155-1.



LOCK JOINT
Reinforced
Concrete Pipe



A Straight Stretch of the 36-inch Norfolk Pipe Line, Bringing Water from Lake Prince to Norfolk, Va.

LOCK JOINT
Reinforced
Concrete Pipe

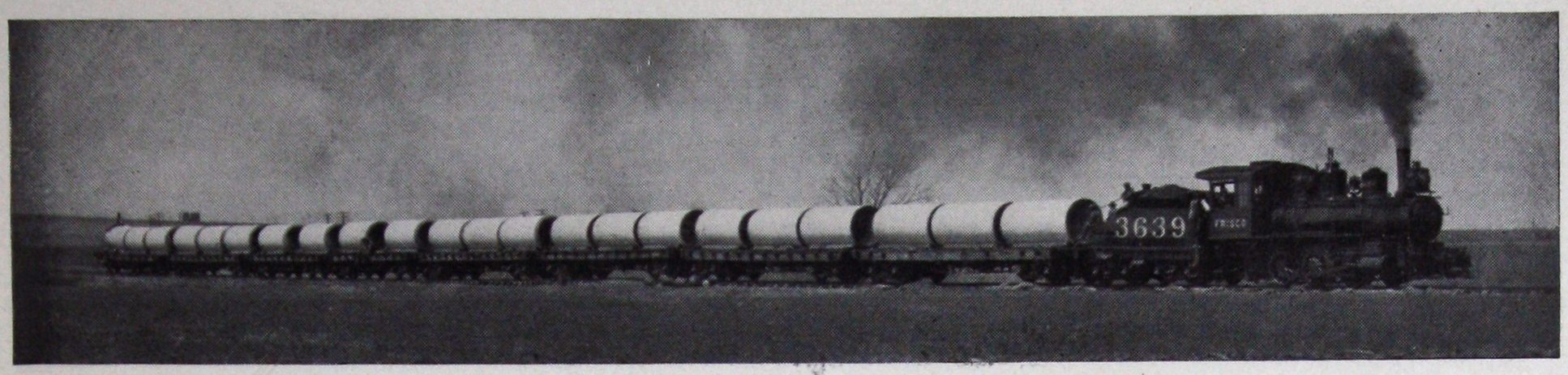
PRESSURE and
SUBAQUEOUS
CATALOGUE

Manufactured and Installed by

LOCK JOINT PIPE COMPANY

AMPERE, NEW JERSEY

Copyright, 1925
Lock Joint Pipe Company.



A Train Load of Pipe for Delivery on the Spevinaw Project.

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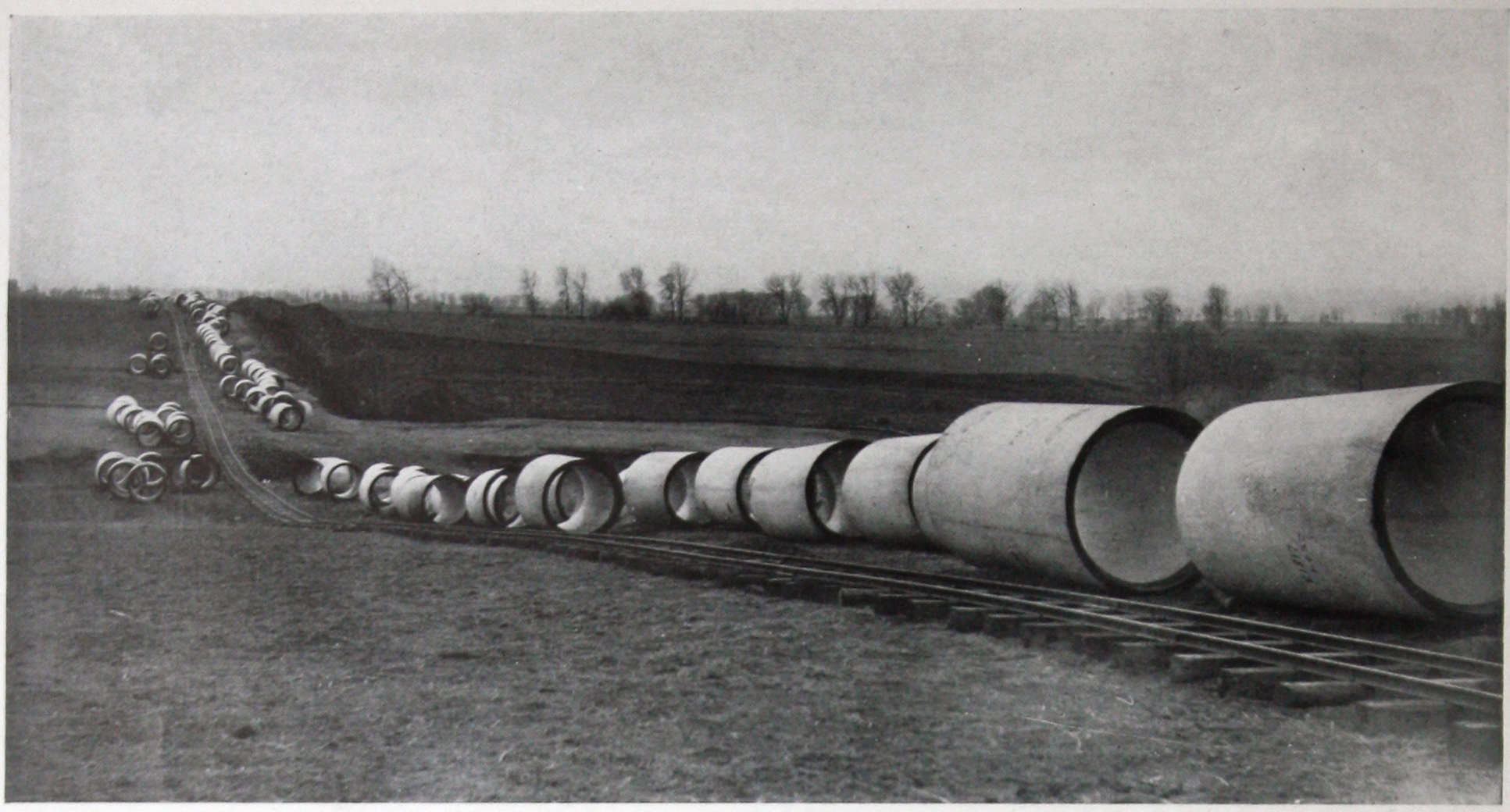
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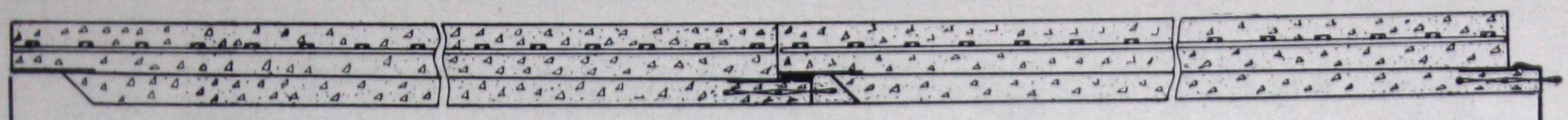
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66-inch Poured Pipe with Lead-Steel Joints Delivered along the Line.



20-inch Centrifugal Pipe Laid Out for the Pipe Line for East Orange, N. J.



Lock Joint Products

Kinds of Concrete Pipe

THE LOCK JOINT PIPE COMPANY specializes in Reinforced Concrete Pipe, and manufactures Reinforced Concrete Pressure Pipe, Sewer Pipe, Culvert Pipe, Subaqueous Pipe, and builds Reinforced Concrete Pressure Lines.

In Forty-One States

Lock Joint Pipe has been manufactured and installed in forty-one States of the United States, all of the Provinces of Canada, and in several foreign countries, aggregating many hundred miles. All of this is now in service and satisfactorily performing the functions for which it was installed.

By U.S. Reclamation Service

Lock Joint Pipe has been adopted as a standard and is being used extensively by the United States Reclamation Service.

This Catalogue

This catalogue deals chiefly with Pressure and Subaqueous pipe. Sewer pipe and Culvert pipe are described in another catalogue, which will be sent upon request.

Three Types

We manufacture three kinds of pressure pipe — Poured pipe, with bar and mesh reinforcement; Cylinder pipe with a welded steel cylinder running through the entire length of the pipe and encased in reinforced concrete; and Centrifugal pipe, made by revolving at a rapid rate a mould with the proper amount of concrete in it, causing the concrete, reinforced with wire or mesh, or with both, to take its form by centrifugal force.

Desirable Features Good Work Under Any Condition

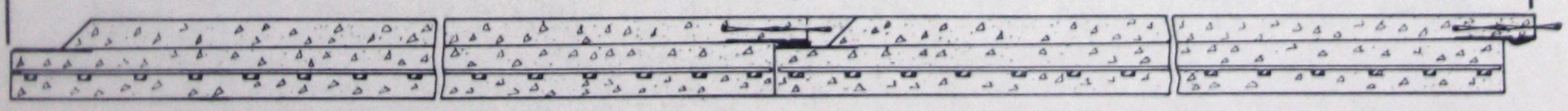
Lock Joint Pipe has been developed with the idea of utilizing as many as possible of the desirable features of pipe line construction which will allow satisfactorily good work to be done under practically any conditions encountered, with the result that they can be laid successfully in wet ditches or in dry, in hot weather or in cold.

Many Miles

Many miles of Lock Joint Pressure pipe line have been installed in the United States and Canada. Among these are the following:

Pipe Lines Built

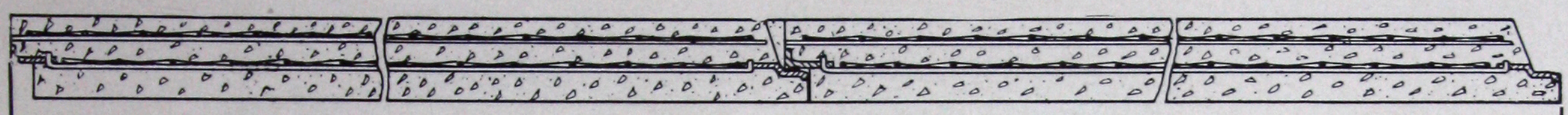
City	*Diam. Inches*	*City*	*Diam. Inches*
Portland, Me.	54	Milwaukee, Wis.	72
Worcester, Mass.	42, 48, 54	Kansas City, Mo.	48
New Bedford, Mass.	60	Tulsa, Okla.	54, 60
Hartford, Conn.	48	(Spavinaw Project)	
Flushing, N. Y.	15	Denver, Colo.	36, 54, 66, 90
East Orange. N. J.	20	(5 contracts)	
Philadelphia, Pa.	66	Greeley, Colo.	27
Baltimore, Md.	84, 108	Ft. Collins, Colo.	27
Cumberland, Md.	36	Dallas, Tex.	36





"Lock Joint City" on the Spavinaw Project, Tulsa, Oklahoma

THE illustration above gives an aeroplane view of the manufacturing yards, sometimes referred to as "Lock Joint City," where fifty-two and a half miles of pipe of diameters of 54- and 60-inch were manufactured for the Spavinaw Water Supply Project for the City of Tulsa, Okla. There are about sixteen miles of pipe visible in this picture.



Pipe Lines Built (Cont'd)

City	Diam. Inches	City	Diam. Inches
(4 contracts)		Ft. Worth, Tex.	36, 48
Washington, D. C.	48	Seattle, Wash.	42
Norfolk, Va.	36	St. John, N. B.	36, 42
East St. Louis, Ill.	48, 54	Winnipeg, Man.	48, 66
		Victoria, B. C.	42

Recent Important Works

We wish to call special attention to our work on the Spavinaw Project for the City of Tulsa, Okla., where we have successfully completed a pipe line, 52-½ miles long, having a diameter of 54 inches and 60 inches, and our work for the City of Denver, Colo., where we have successfully completed five different contracts, aggregating some 15 miles of pipe, varying in size from 36 inches up to 90 inches diameter.

Pressures

We build our pipe depending on size and character for pressures up to 400 feet.

Greatest Satisfaction

All of these lines have given the greatest satisfaction. Their high qualities have appealed alike to the technical official and the layman. No complaints, nothing in fact but the most gratifying expressions of approval, have been given us by the authorities in charge of their maintenance.

Details of Great Importance

In a catalogue of this sort it is, of course, impossible to detail every operation and precaution necessary in the making of reinforced concrete pressure pipe. These consist of innumerable things of apparently insignificant importance, but experience has taught that they are vital to the proper performance of a pipe line.

Twenty Years and Hundreds of Miles

The Lock Joint Pipe Company, founded in 1905, has had twenty years of time and hundreds of miles of experience to bring its pipes to the high degree of success which they now enjoy.

Scope of Our Work

The Lock Joint Pipe Company does nothing but manufacture reinforced concrete pipe and build reinforced concrete pipe lines. This catalogue should give an idea of the scope of our work as it relates to pressure pipe.

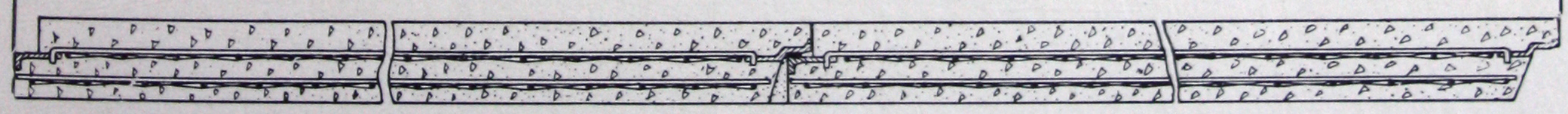
Organization of Specialists

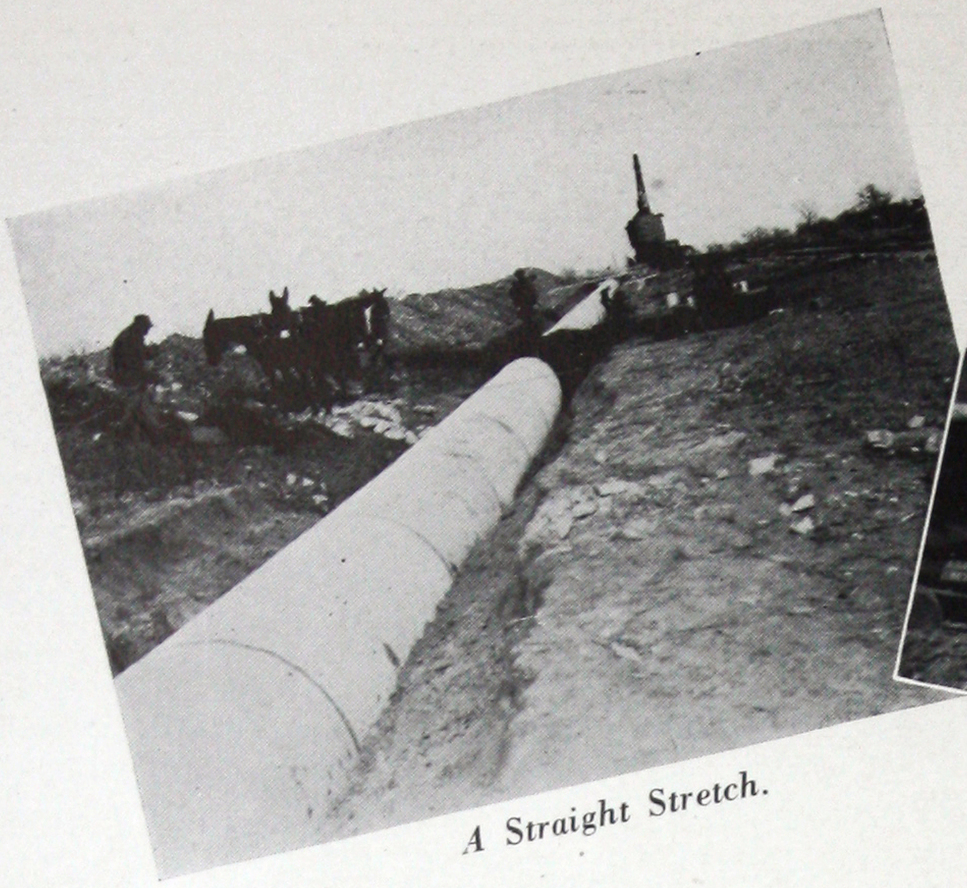
Ability and Loyalty

During our 20 years of existence we have fortunately been able to build up an organization of trained men who are specialists in their line and who are able to meet any emergency which might arise in pipe line construction. Like any other business conducted on a large scale, success depends largely upon the ability and loyal cooperation of the men in the organization, and we take pride in stating that our men have shown the highest degree of loyalty, not only to ourselves but also to the interests of our clients.

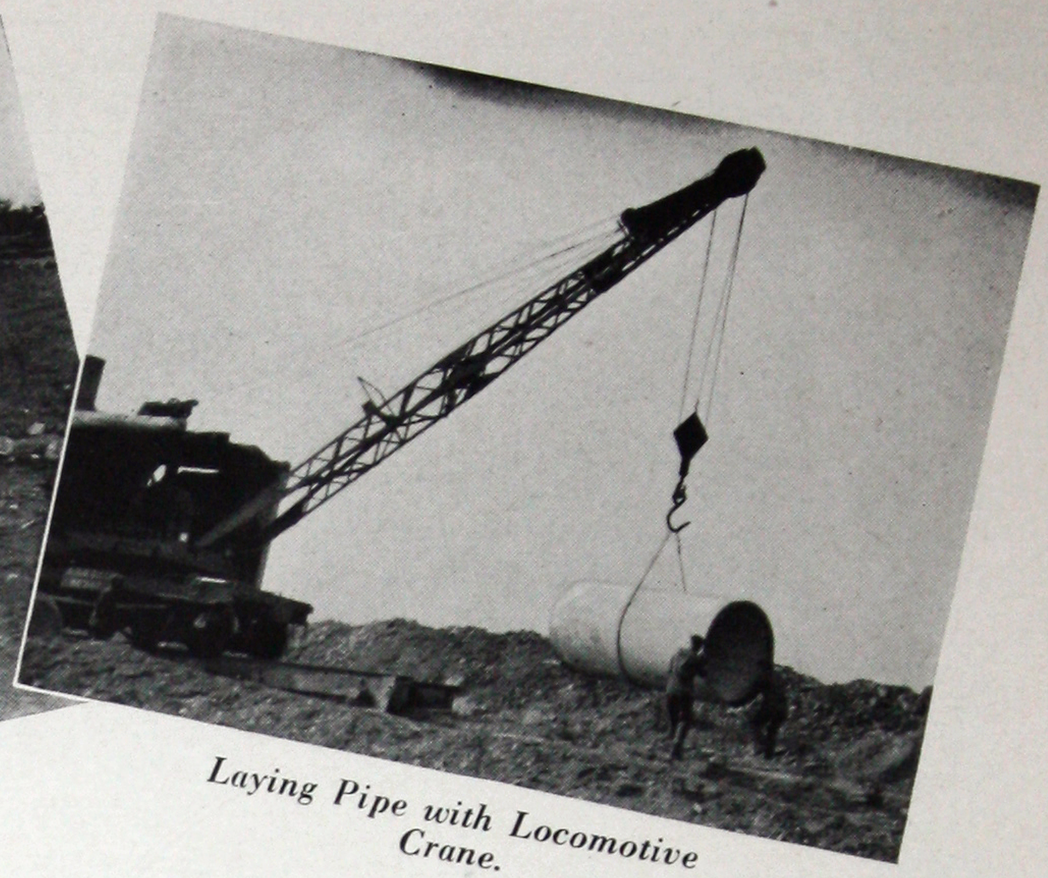
References

We do not publish letters of recommendation but offer as reference anyone for whom we have done work.

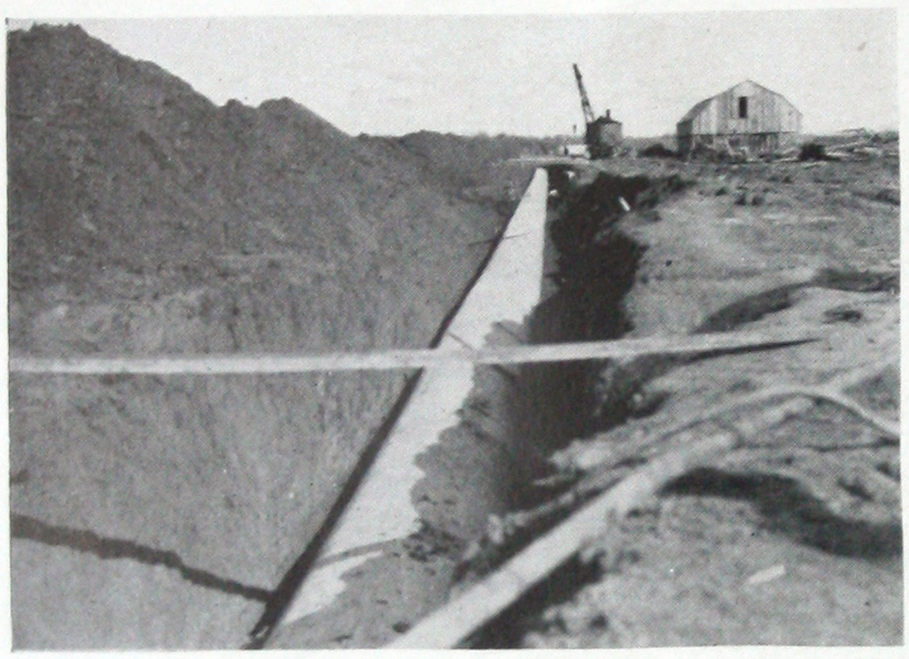


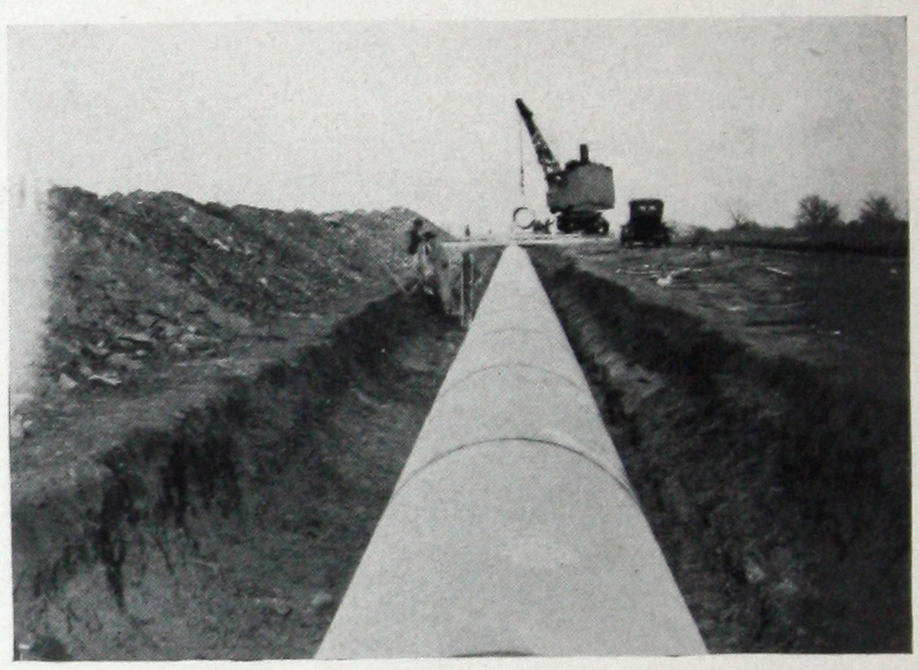


A Straight Stretch.

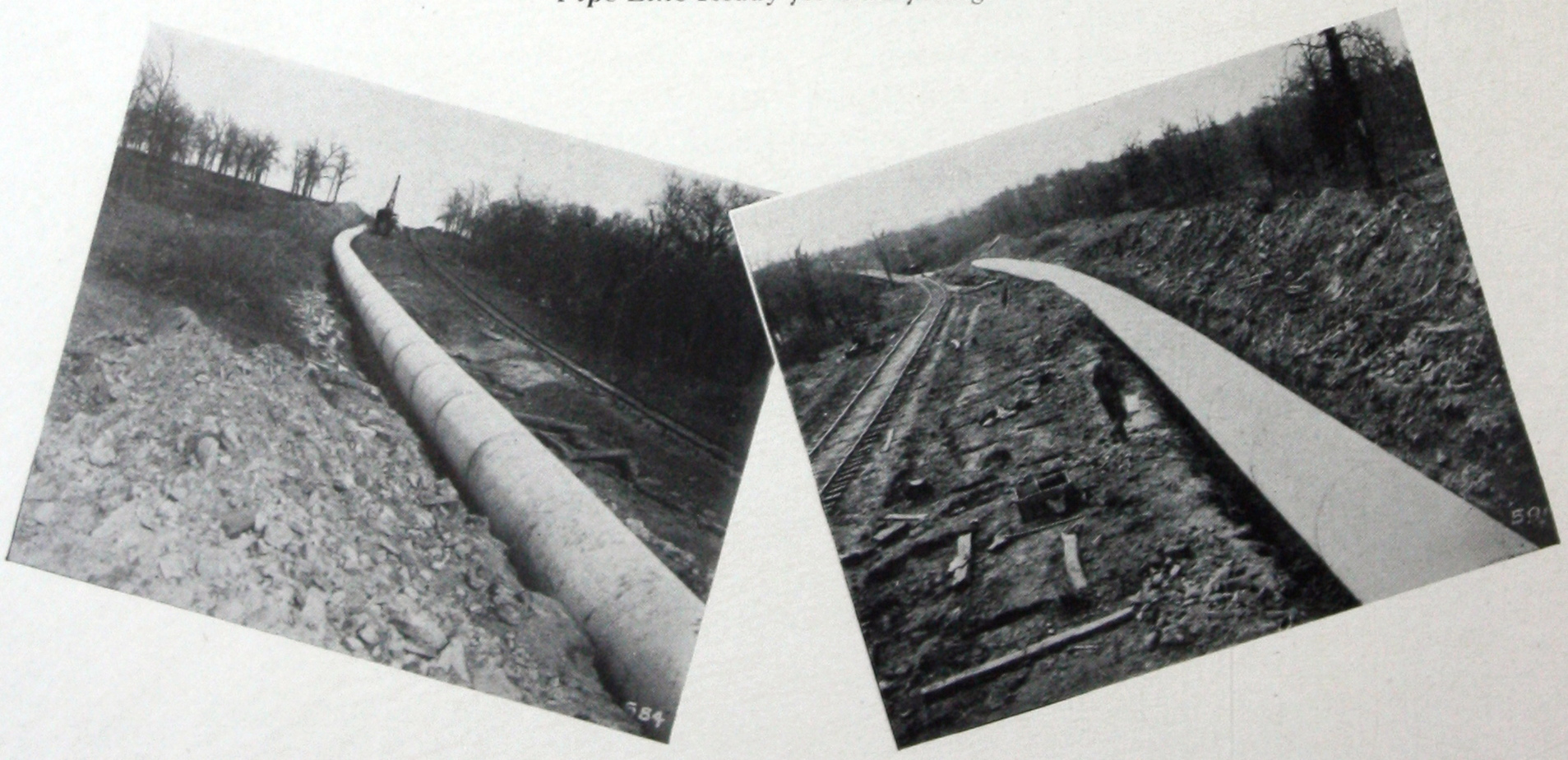


Laying Pipe with Locomotive Crane.

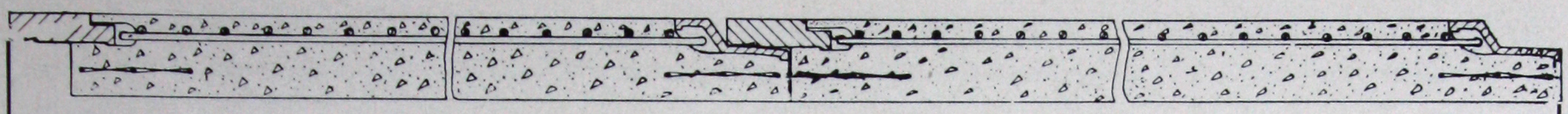




Pipe Line Ready for Backfilling.



Sweeping Curves.



Every Pipe Line Should Possess

Permanence
High Carrying Capacity
Permanently High Carrying Capacity
Tightness
Good Joints
Flexibility
Ease of Repairs
Safety

Permanence

A PIPE LINE must be permanent. Concrete is one of the oldest building materials known to mankind. Its enduring qualities are illustrated by many historic structures.

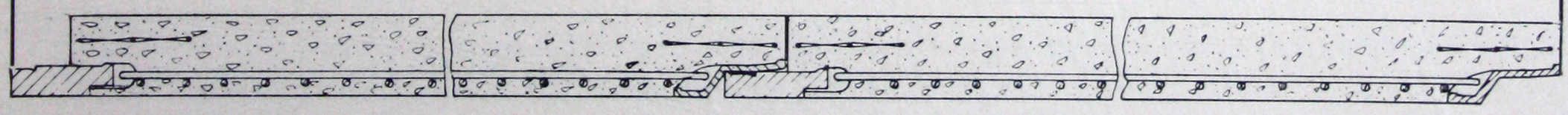
Long Use

The Lock Joint Pipe Company has adapted this imperishable material to one of the most important of all municipal uses, the transportation of water under pressure. Reinforced concrete pipes have long been used for water supply, both abroad and in the United States, with many instances of more than fifty years of successful use.

Assurance

Dense, rich, well made concrete is well recognized as a very permanent construction material. Water is the best seasoning agent for concrete and concrete in continual contact with water is well known to be at its best and to have a long life. Dense concrete is recognized, too, as the best and most permanent protective coating for steel; therefore, a pipe composed of concrete and steel, where the steel is protected by admittedly the best preservative, namely the best grade of concrete, and the concrete constantly in contact with its best preservative, namely water, certainly offers every reasonable assurance of an extremely long life and permanence.

A very large portion of modern engineering construction depends upon these very principles for its lasting qualities.





Panorama of Pipe Yard.

Lock Joint Pressure Pipe Lines Are Permanent

High Carrying Capacity

INASMUCH as a pipe line is constructed for the sole purpose of transporting water, the ideal pipe line is the one which, with a given hydraulic slope, will safely carry the largest volume of water and keep on carrying it.

No Tuberculation

To approach this result, as many as possible of the known hindrances must be removed. Tuberculation is the main factor in cutting down the flow. In metal pipes this agency in a short time will decrease the flow of water by millions of gallons per day, and generally at a time when the water is most needed.

Concrete is not subject to tuberculation, and therefore Concrete pipe does not lose its capacity. Properly made Reinforced Con-



Capacity One and One-third Miles of 54- and 60-inch Pipe per Week.

crete pipe, fitted with our *Expansion Joints*, can be made truer than metal pipes; and this is another reason for their superior Carrying Capacity.

Tests

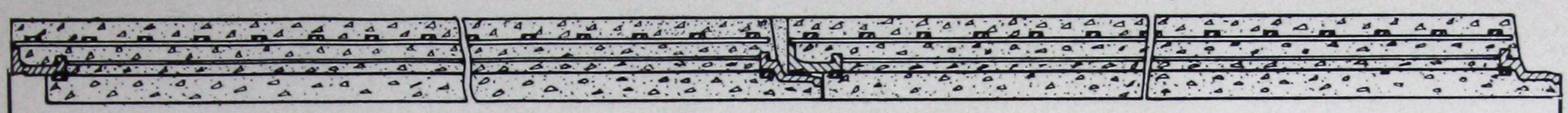
Tests for flow were made by Colonel Dabney H. Maury and Mr. Walter H. Taylor, III, Director of Public Works, at Norfolk, Va., on a 36-inch Lock Joint line, 3 years old, and "*C*" in Williams-Hazen's formula was found to be 142, while a stretch of cast iron pipe in the same pipe line was found to be 107.

Mr. Fred C. Scobey, of the Division of Engineering of the U. S. Department of Agriculture, who has made a very exhaustive study of co-efficients in various kinds of pipe lines, tested the 54- and 60-inch Spavinaw Pipe Line at Tulsa, Okla., and obtained a value for "*C*" of 152. This line is 52½ miles long and offered unusual opportunities for accurate tests.

The details of these tests are herewith presented:



Long Gentle Curves Crossing the Mason-Dixon Line for the Cumberland Water Supply.



Values of "C" in the Tulsa and Norfolk Pipe Lines

SUMMARY OF RESULTS OF RECENT OBSERVATIONS ON THE HYDRAULICS OF SEVERAL LONG SECTIONS OF TWO LOCK JOINT REINFORCED CONCRETE PRESSURE PIPE LINES.

	Tulsa, Oklahoma Spavinaw Water Supply Line New			*Norfolk, Va. Lake Prince Water Supply Line 3 years old*	
	Sections			*Sections*	
	*1**	*2***	*3*	*1*	*2*
Diameter of pipe in inches	60	60	54	36	36
Length of line under test in miles	6.6	15.3	4.0	2.17	2.47
Mean velocity, feet per second	2.25	2.25	2.63	2.89	2.90
Rate of discharge, millions of gallons per day	28.596	28.550	27.029	13.20	13.23
Slope of hydraulic gradient, feet per 1,000	.2052	.1880	.2851	.658	.623
Value of "*C*" (Williams-Hazen)	145.4	152.4	152.1	138.	142.
Value of "*C*" (Scobey)	.386	.402	.409	.380	.392

NOTE: — * This section had a total curvature of 455.7 degrees.
** This section had a total curvature of 52.3 degrees.

No Deterioration

On a nine-foot line in Baltimore — while there was no opportunity for measurements — the Engineers made a careful inspection of the interior of the pipe after ten years of operation and reported the interior surfaces just as they were when the line was first put in service, and "were unable to find a single spot where the concrete was not perfect."

Water-Tightness

Invisible Leakage

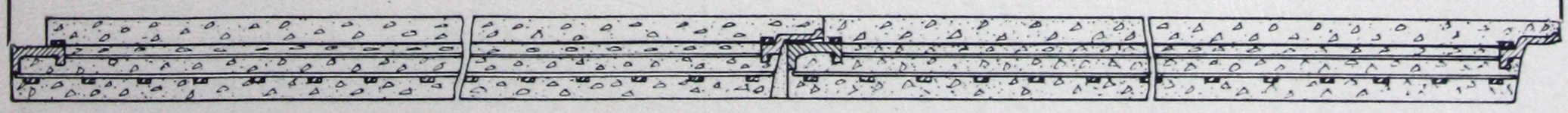
There are very few precise data concerning measured leakage in pipe lines in general. It is not uncommon to conclude that there is no leakage if no water is seen on top of the ground above the pipe line. Experience in trying to account for all water in leakage tests has proven, however, that this is not true, for many thousands of gallons per mile per day may be leaking without any visible signs of it.

Guarantee

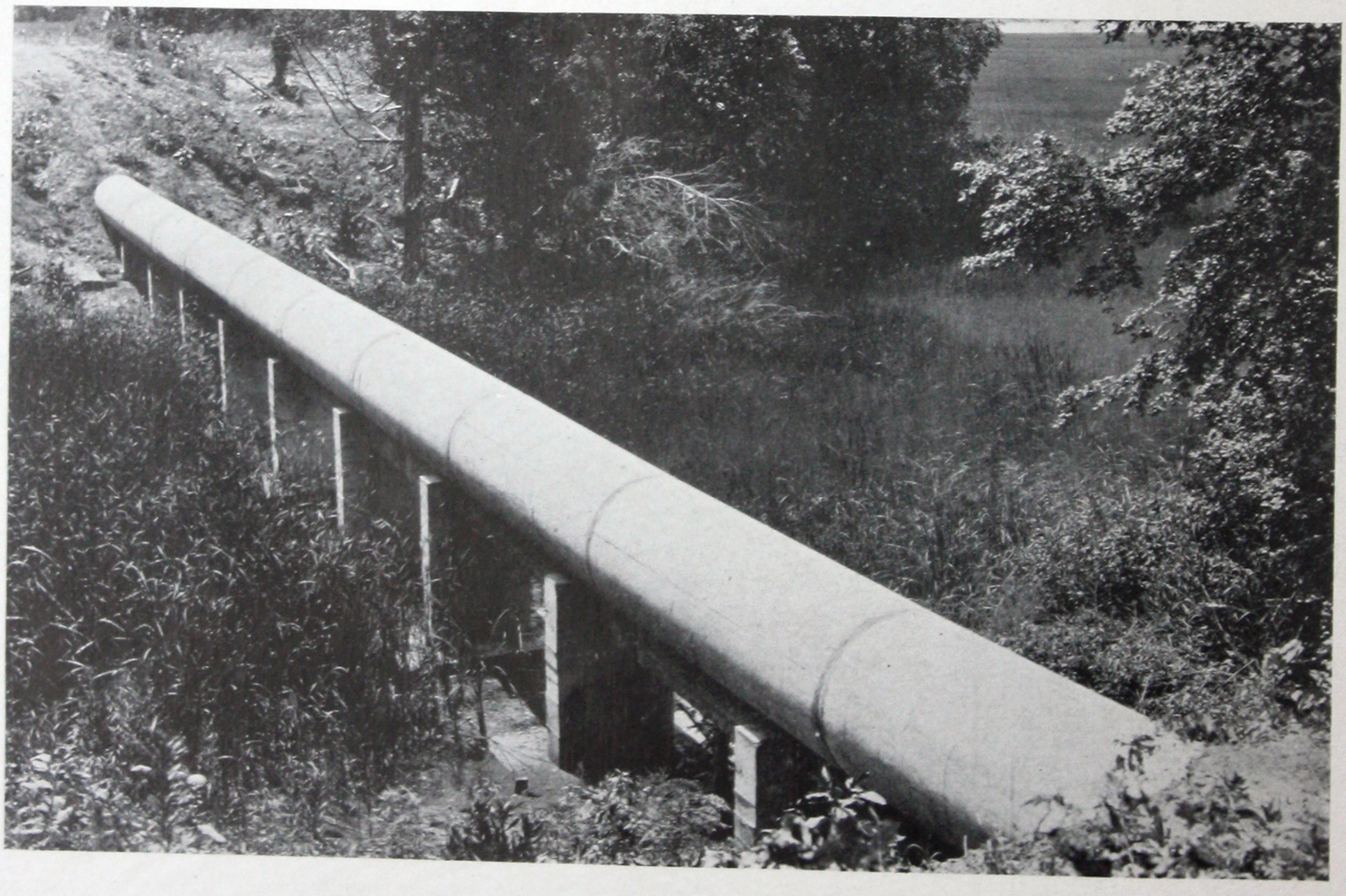
The Lock Joint Pipe Company guarantees that the total leakage from a finished pipe line will not exceed a specified amount.

Established Record

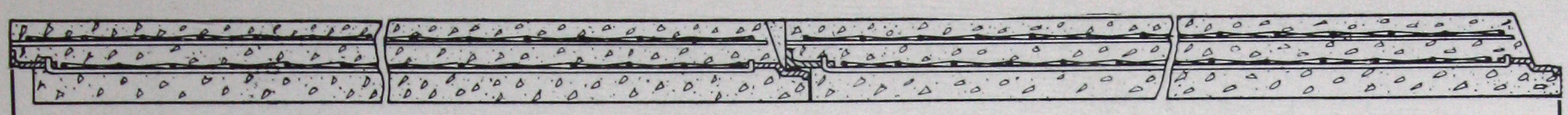
Every Lock Joint pipe line is tested for leakage with the result that there is a well established record derived from actual experience, proving that the loss of water from all causes, evaporation and seepage, as well as visible leakage, is very low indeed.







36-inch Lead-Iron Joint Cylinder Pipe on Norfolk Line.



Leakage Tests

Results of Leakage Test On Lock Joint Pressure Pipe Lines

Location	*Diameter In.*	*Head Ft.*	*Leakage in Gallons per Inch Diameter per Mile per Day*	
			Allowed by Specifications	*Measured On Test*
Dallas, Tex.	36	30- 80	225	118
Fort Worth, Tex.	48	20- 60	275	115
Hartford, Conn.	48	50	225	205
Milwaukee, Wis.	72	40- 52	225	74
Kansas City, Mo.	48	100	350	292
Winnipeg, Can.	66	45- 95	225	73
Norfolk, Va.	36	30-160	125	83.6
Denver, Colo.	54	30-120	167	141
East Orange, N. J.	20	114	225	93
Greeley, Colo.	27	30-108	240	142
Baltimore, Md.	84, 108	80	256	88
Tulsa, Okla.	54, 60	115	165	83
Denver, Colo.	66	185	177	130

Gets Better

Seepage from a Lock Joint Reinforced Concrete Pipe line is greatest when it is first filled and tested, but the line immediately starts to take up and gets tighter all the time. Thus there is not only the assurance of a good pipe line to start with, but a better one as time goes on.

Good Joints To Build A Pipe Line

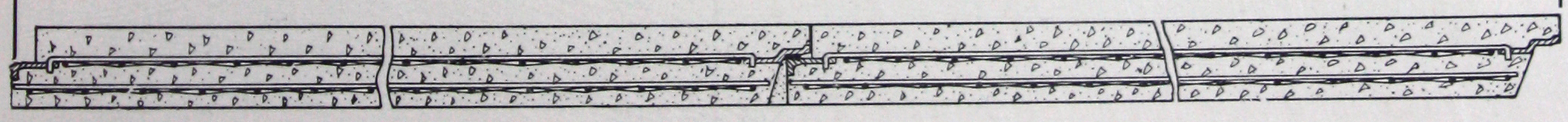
An essential feature of a good pipe line is *effective expansion* joints. The making of individual lengths of pipe to successfully withstand internal pressure is a matter only of providing a wall dense enough to prevent the passage of water, and the requisite amount of reinforcement to prevent rupture. But to build a *pipe line* that is equally tight, and that will remain tight, means that the joints between pipe units must be water-tight under all conditions and must, at the same time, be flexible enough to take care of all movements which are sure to result from expansion, contraction, or settlement in the pipe lines, and be localized to each pipe unit.

Movements At Joints

Expansion, contraction, and settlement are sure to occur in every pipe line built. Experience and close observation have shown that movement occurs in a large percentage of joints, but with no regularity. Therefore, the only sure way to guard safely against such movement is to provide for it wherever it can occur, and that means an Expansion Joint at Every Joint.

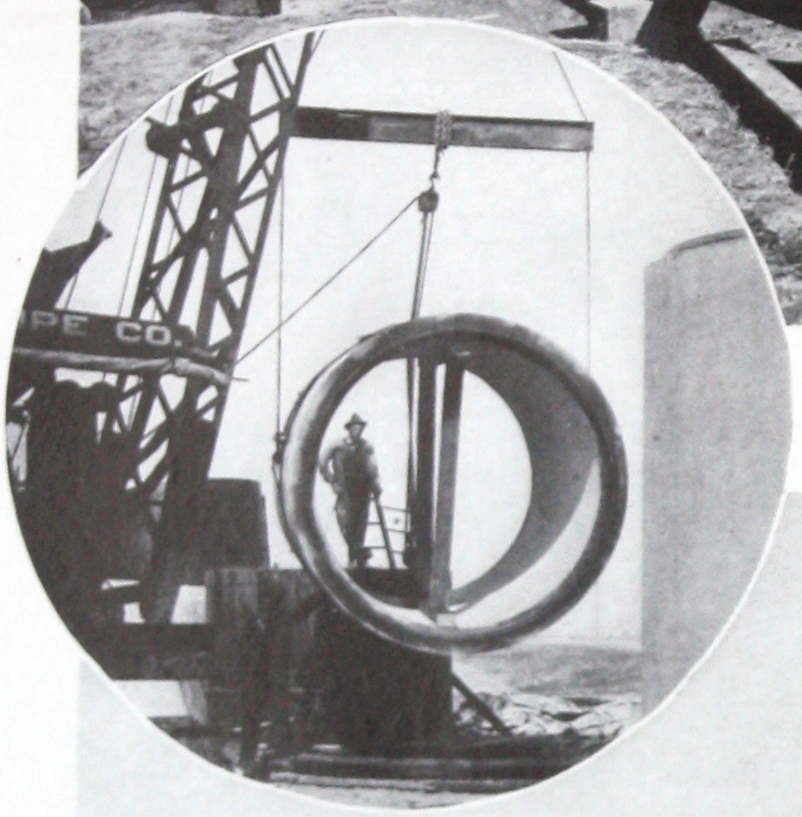
Every Joint An Expansion Joint

Lock Joint Pressure Pipe does provide this very thing.



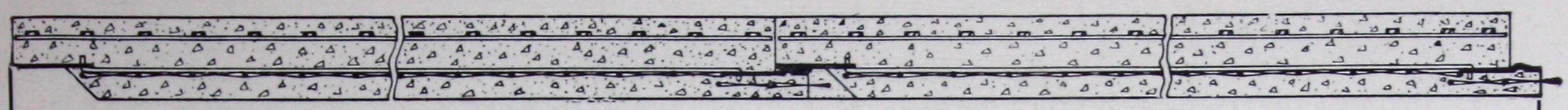


84-inch





90-inch (Weight 15 tons)



Flexible and Elastic

In every pipe line there is need for the qualities of flexibility and elasticity. At some time or other movements of a pipe line are inevitable, and if such movement has a tendency to pull the pipes apart, a joint which will permit this without breakage and without leakage gives the desired quality of flexibility. Lock Joint Pipe Lines have joints which can expand or contract on one side or on the other, without injury or leakage.

Cannot Blow Up

It is impossible for the concrete in a Lock Joint pressure pipe line to blow out, and this fact, together with the elasticity of the steel reinforcement, makes sure that such a line will continue to serve as a good carrier of water and not, as is the case with pipe lines of brittle and less elastic material, blow up and lose great quantities of water at one point, thereby interrupting the supply and causing damage. *Lock Joint Pressure Pipe Lines are flexible and elastic.*

Small Risk of Rupture and Ease of Repair

Safest Water Carrier

Accidents of the kind which now and then occur in pipe lines, flooding property, tearing up pavements, undermining buildings, and causing large money damages, have never occurred in Lock Joint Pressure Pipe Lines. The steel reinforcement has a large factor of safety, and the heavy wall of concrete acts with the steel in a way to utilize its strength and its elasticity to best advantage. Our experience has not been marred by a single burst. In many full-sized tests under extraordinary stresses, no burst has ever occurred. We confidently claim that breaks of this kind will not occur in Lock Joint Pressure Pipe Lines.

To Seal A Crack

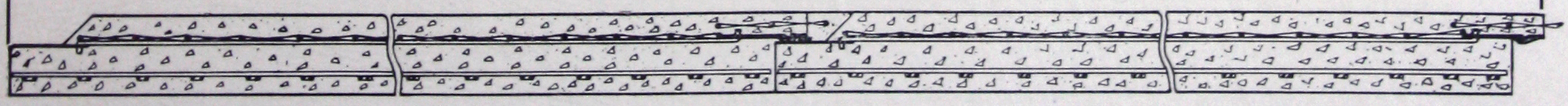
In a few rare instances cracks have occurred as a result of unequal settlement, but these have been remedied without difficulty by covering the crack with a thin metal strip, clamping it upon the pipe and leading away the flow of water, and then encasing the whole thing in concrete. This method can be used both for circumferential and longitudinal cracks. *Lock Joint Pressure Pipe Lines are easily repaired in the rare instances where such is required.*

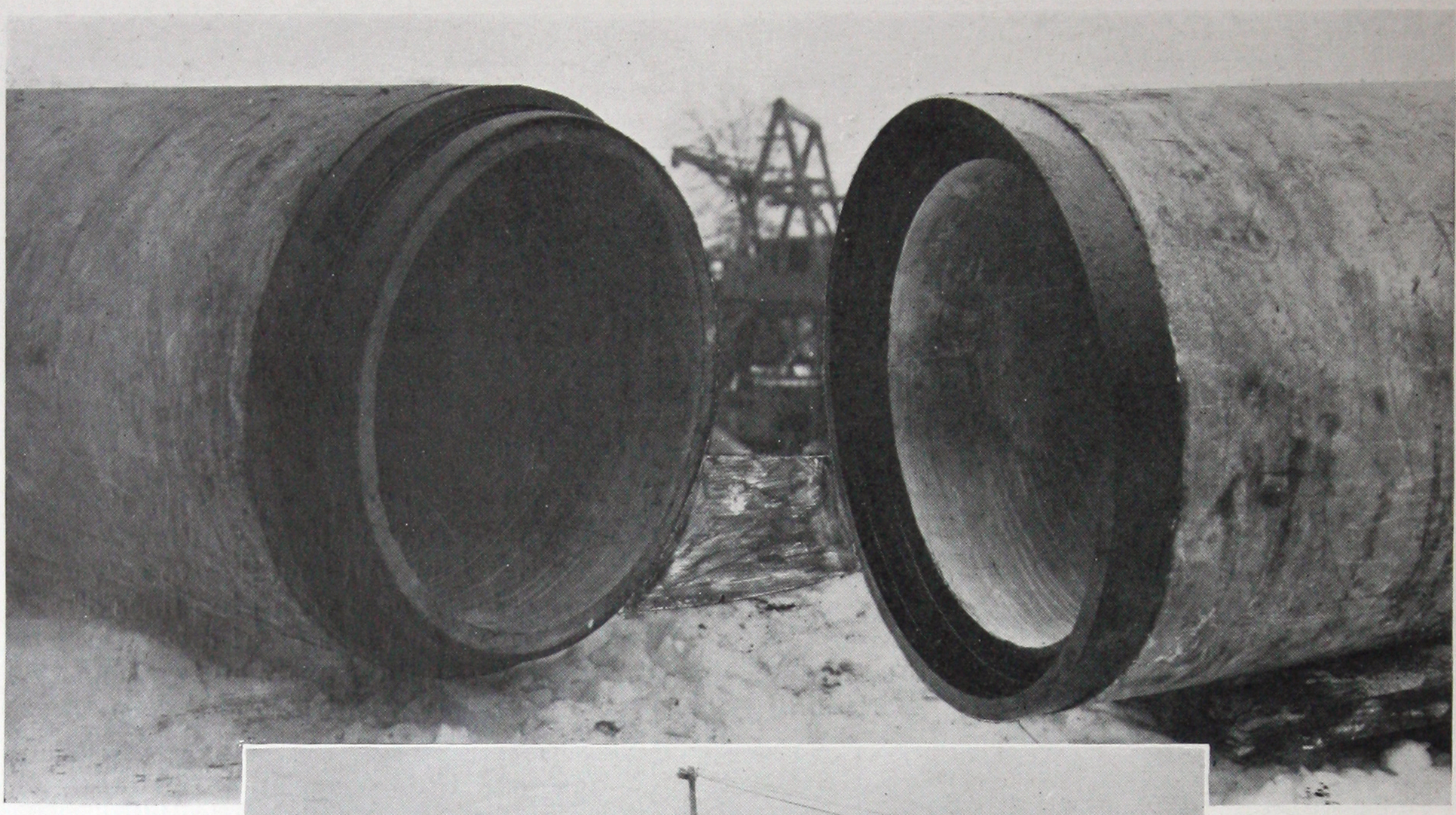
Safety

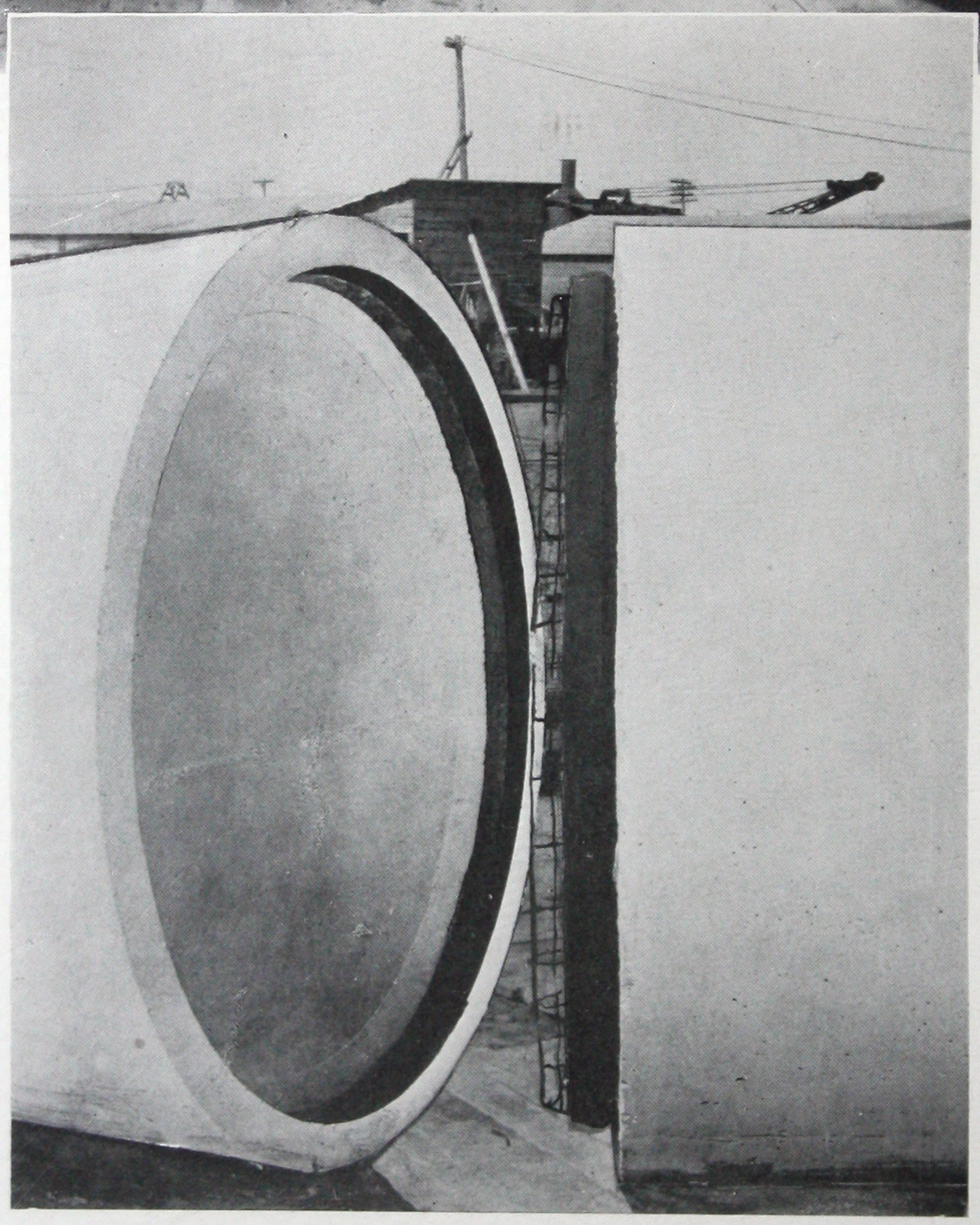
A pipe line which cannot blow up is safe. Joints in a pipe line which cannot blow out are safe. A pipe line which remains at all times and under all conditions a good carrier of water means safety. A pipe line which cannot endanger neighboring property by flooding means safety.

The All-Important Qualities

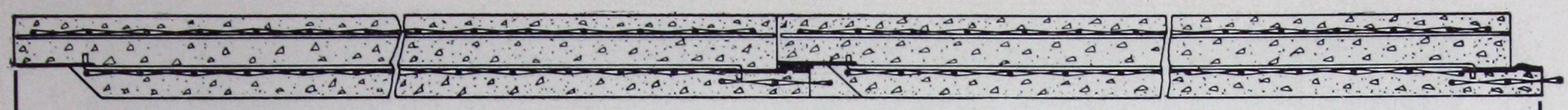
A Lock Joint Pressure Pipe Line, built of permanent material, which cannot blow up, whose joints cannot blow out, and whose carrying capacity remains a maximum, furnishes safety with respect to the all-important qualities that any pipe line should possess, namely, permanence, high carrying capacity and an uninterrupted supply. *Lock Joint Pressure Pipe Lines are safe.*







Top — Bell and Spigot Ends of Lead and Iron Joint.
Bottom — Lead and Steel Joint.



Expansion Joints

Tight, Flexible, Rugged, Durable, Simple

FROM the foregoing it will be seen that the expansion joint is a most vital part of a pressure pipe line. Our expansion joints are tight under all conditions, flexible, rugged, durable, and simple, offering the least possible obstruction to flow.

Two Types of Joints

We make two types of pressure joints, commonly called by the following names:

"Lead and Iron Joint", "Lead and Steel Joint"

Proven Merits

both of which are true EXPANSION JOINTS. Their tightness and flexibility have been well proven by use.

Successful Development

Cannot Blow Out

The development of reliable expansion joints is the one thing that has made possible the successful use of the very desirable qualities of reinforced concrete for water lines operating under pressure. These joints are more fully described below. They possess the merits of tightness, flexibility, simplicity, ruggedness and permanence. They are so constructed that they cannot blow out, and every joint is an expansion joint.

Durable Materials In Joint

Flexible Material In Joint

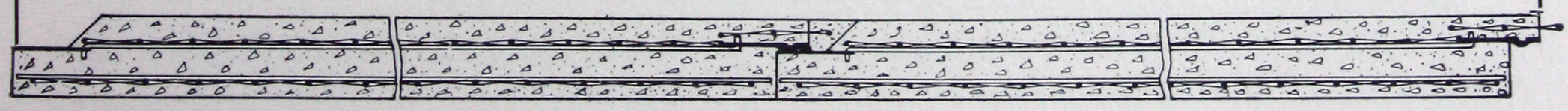
A permanent pipe line must have permanent joints. This eliminates all short-lived substances, such as asphaltic material or rubber gaskets. The joint material must, in addition, be reasonably plastic, to permit the readjustment of shape which is necessary to accommodate joint movements. This eliminates any rigid material, such as cement mortar.

Lock Joint Joints Are Good

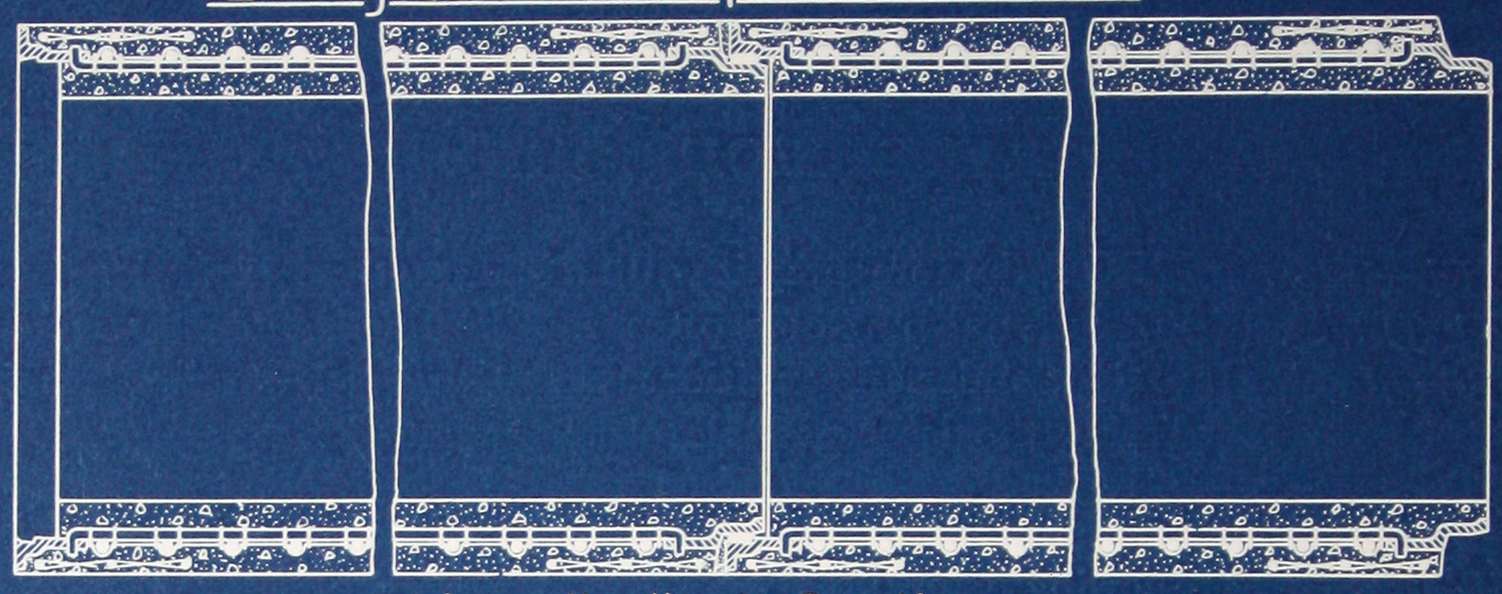
Lock Joint Expansion Joints, being made of protected steel or cast iron backed substantially with concrete, together with fibre-filled lead gaskets, fulfill all the above requirements in a high degree.

Repairs A Minimum

Repairs on Lock Joint Pressure Pipe Lines, whether to the pipe itself or to the joint are a minimum. On all the pressure pipe lines laid by us, less than one fiftieth of one percent of all the joints have had to be re-made or re-caulked on account of being defective.



"Every Joint an Expansion Joint"



Longitudinal Section.

Standard Length 12 Feet.

Section of Joint before Putting Pipe Together.

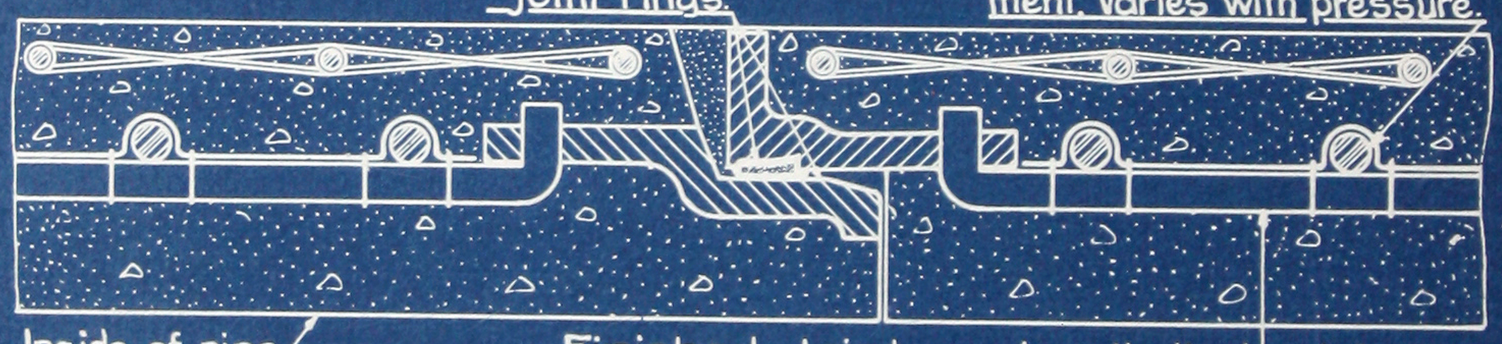


Machined cone-shaped end of spigot, when forced into bell, automatically caulks the lead gasket and seals the joint.

Fibre filled lead gasket which is caulked by cone-shaped end of spigot entering bell.

Machined cast iron joint rings.

Circumferential reinforcement. Varies with pressure.

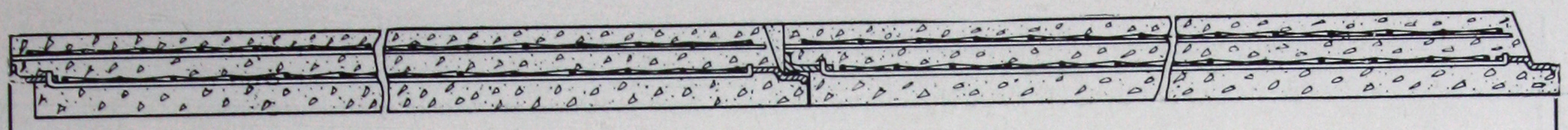


Inside of pipe

Finished Joint.

Longitudinal reinforcement. Ties joint rings together.

Lead and Iron Self-caulking Joint.
Sizes-12" to 48"
Patented.
LOCK JOINT PIPE CO.
AMPERE, N. J.



Lead and Iron Expansion Joint

THE Lead and Iron Expansion Joint is furnished on pipes up to 48 inches in diameter.

Iron Ends
Lead Gaskets
Continuous Ring
Wedge-Shaped

By reference to the drawing opposite, which illustrates one type of this joint, it will be seen that bell and spigot cast iron rings of a special shape are moulded in the opposite ends of each pipe, first however, having been built as an integral part of the reinforcement. The surfaces of these rings, coming in contact with the lead gasket, are accurately machined. The lead gaskets are filled with cotton fibre in order to give them the required elasticity. The gaskets are rolled to a slightly flattened shape and bent to a ring of the proper size and the ends are sweated together, forming an endless ring and hermetically sealing the fibre core. This gasket is placed in the bell end of the pipe. The bell is provided with a shoulder and a groove in the form of a reverse wedge. The end of the spigot is tapered, and back of this taper is a perfect cylinder.

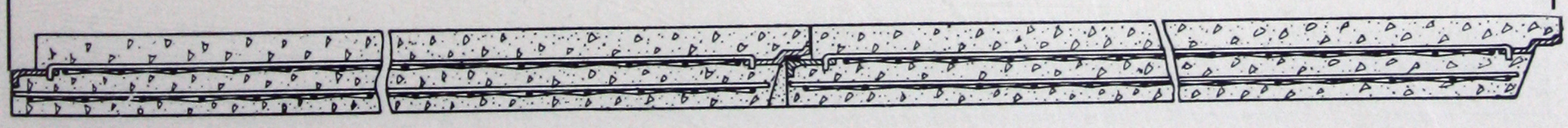
Laying and Jointing
Pulled Together

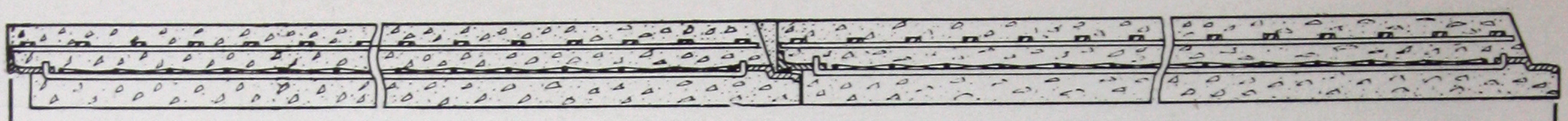
The laying and jointing of the pipes is effected by means of a simple rigging, consisting of a band over the top half of the preceding pipe and a wire-rope sling connected to this band and extending around the bottom half of the preceding pipe. Connected to this are rods, one on each side, extending to a point slightly beyond the end of the pipe being laid. These rods are threaded on their ends and pass through a strongback across the bell end of the pipe. Heavy brass nuts are put on the ends of the rods and the taper end of the spigot is lightly entered into the bell and against the lead gasket ring. The pipes are then ready for being forced together, and this is done by tightening up on the nuts by means of large ratchet wrenches. As soon as the strain is taken, the band around the pipe previously laid tightens and clamps itself to the pipe, causing the pipe being laid, and which is suspended from the laying rig, to move forward, and the spigot to seat itself into the bell.

Automatically Caulked
Thoroughly Caulked

As the pipes are pulled together, the taper of the spigot forces itself through the annulus of the lead gasket, automatically caulking it radially against the bell. At the same time it pushes the gasket forward against the shoulder of the bell and into the groove forming a reverse wedge. The pipes are forced together until the taper portion of the spigot has passed beyond the lead, and the lead lies caulked for its *entire depth* between the bell and the cylindrical portion of the spigot.

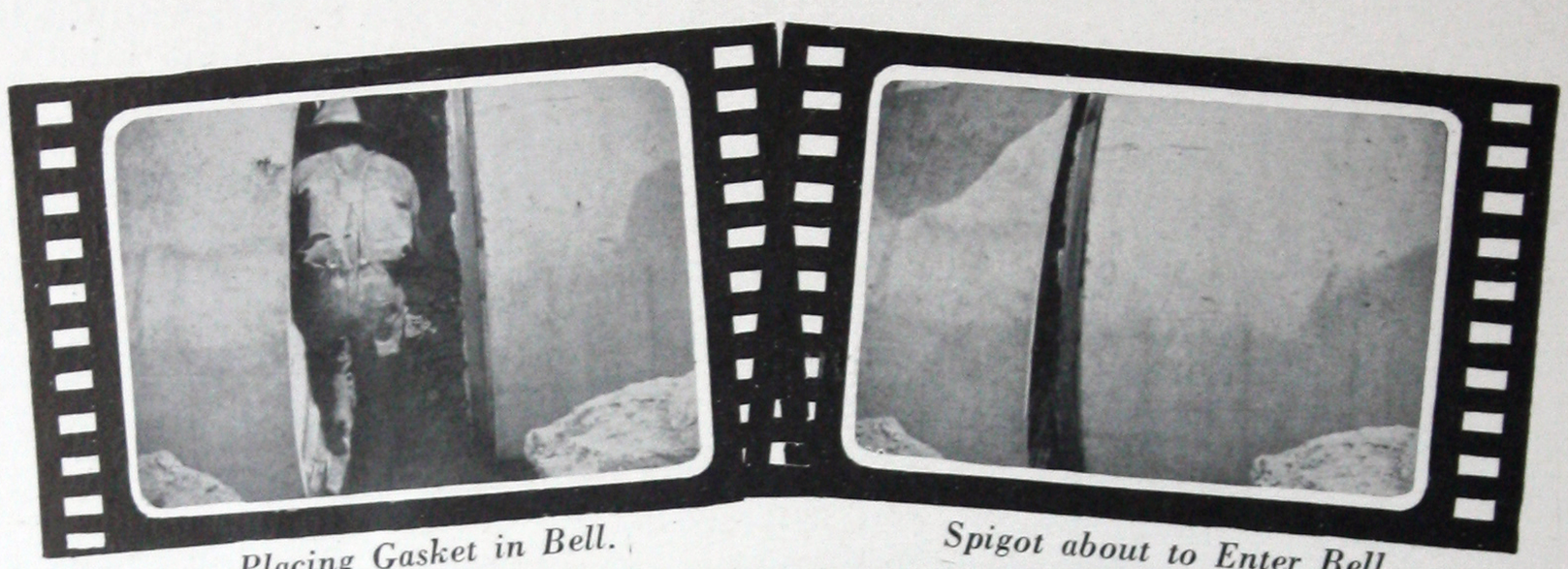
The gasket cannot blow out. It always remains in a definite and fixed position in relation to the bell, while the spigot can slide back and forth on the lead without permitting any leakage.





Very Flexible — This joint allows for an extreme of expansion and contraction and also provides for a great deal of deflection, which will take care of considerable curvature in the pipe line or settlement in the trench. It is easily possible to take these pipes apart and re-lay them.

No Bell Holes — These joints do not require bell holes, nor do they require any caulking of the joint by hand. These features are especially valuable where bad trench conditions are encountered which would cause delays and large expenses, due to constructing and maintaining dry ditches and bell holes. They eliminate bad joints at the bottom in wet trenches. *When the pipe is laid the joint is made.*



Placing Gasket in Bell. *Spigot about to Enter Bell.*

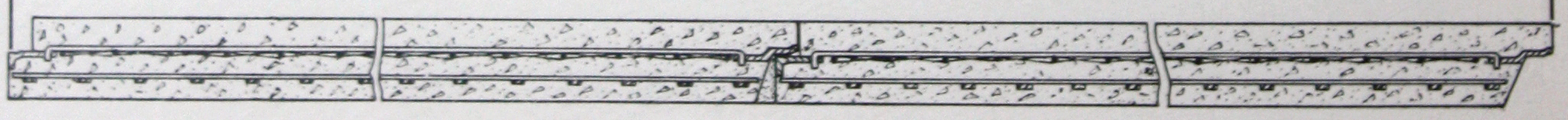
Spigot Almost Home in Bell.

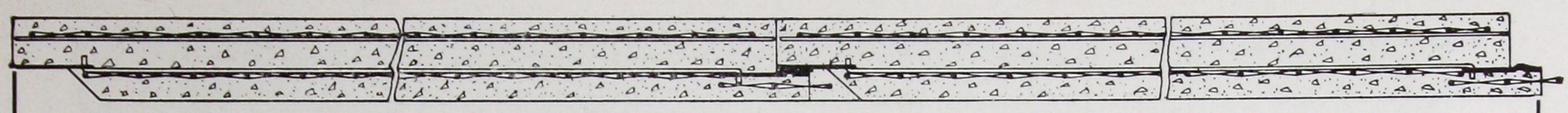
Making the Joint

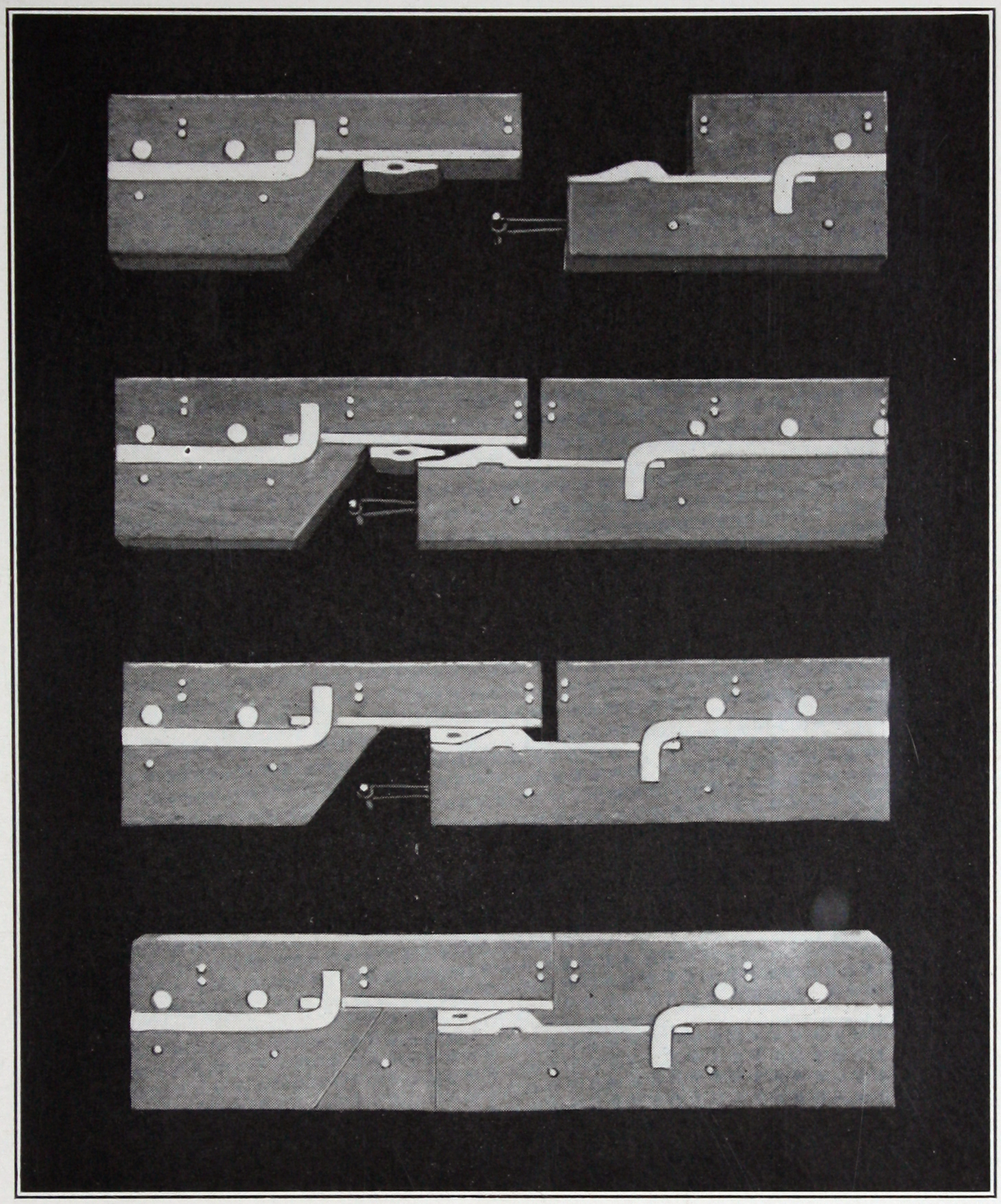
THE three pictures above are "stills" taken from a recent moving picture film showing our Lead and Steel Joint being drawn together.

They come from portions of the same exposure not far apart and thus indicate not only the speed with which this joint is made, but also its great simplicity. One gang has laid as many as eighty pipe lengths (1,000 feet of pipe line) when fitted with this joint in an eight-hour working day.

Another big advantage of this type of joint is that backfilling may be done immediately after the "pulling up" and the final completion of the joints may be left until later, to be done from the inside of the pipe after it has had adequate opportunity for settlement.







A Really-Dependable Expansion Joint

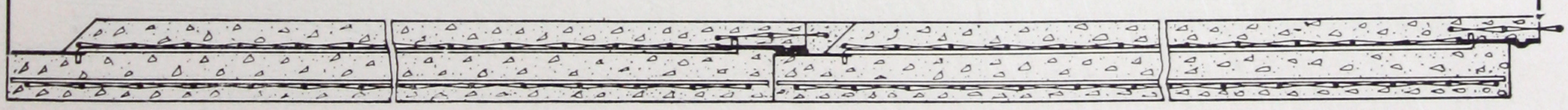
ABOVE are four cross-sectional views through one wall of pipe, showing our Lead-and-Steel Expansion Joint in various stages of being drawn together and finished, the under surface being the inside of the pipe.

Top. Shows spigot about to enter bell. Note gasket in position inside latter and reinforcement projecting into joint space from the former.

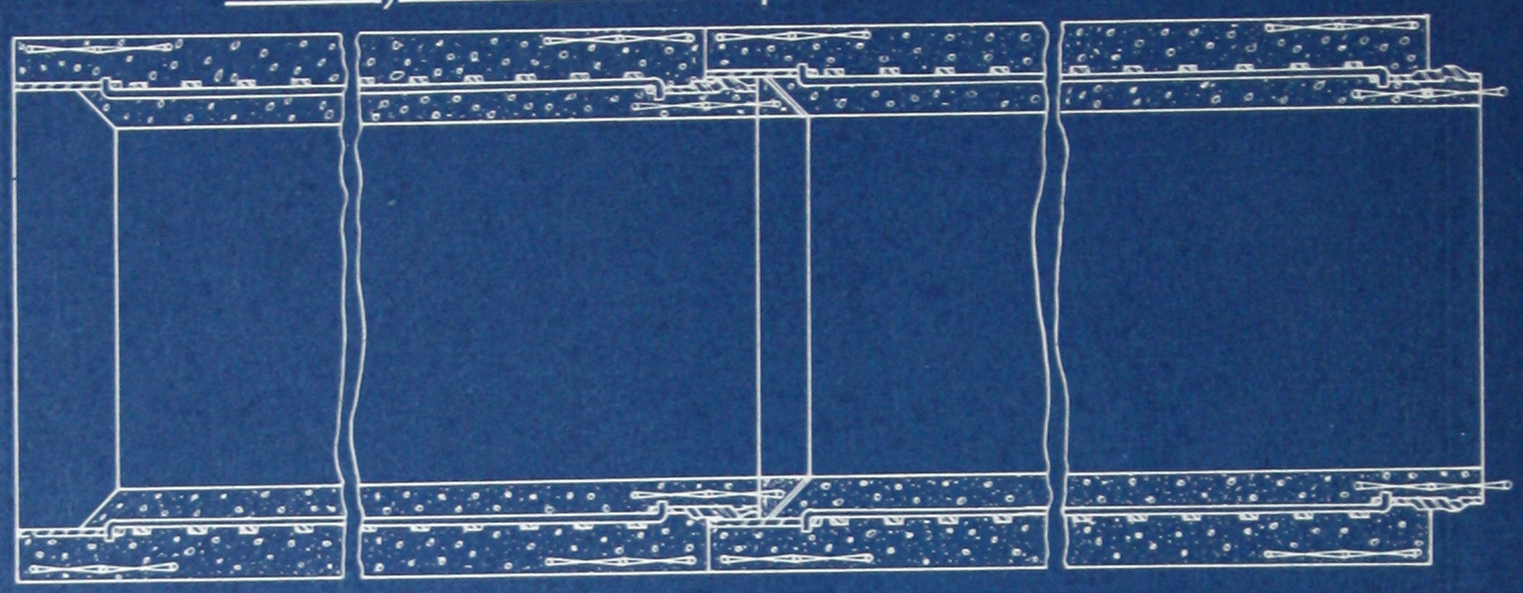
Second. Shows spigot home in bell, the steel ring at end being of such a shape as to form wedge-shaped recess.

Third. Shows gasket tightly caulked and firmly in place.

Bottom. Shows finished joint, which includes the filling of the recess inside the pipe with cement. This surrounds the reinforcement which protrudes from the spigot and is put in place from the inside after the pipes have had adequate opportunity for settling.



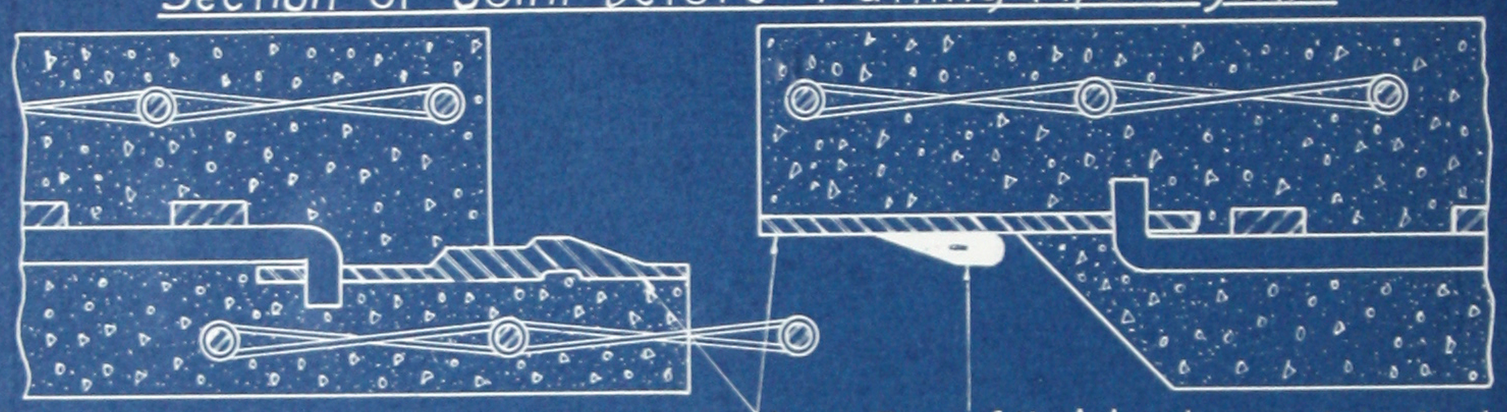
"Every Joint an Expansion Joint"



Longitudinal Section

Pipes Made in 8' to 12' Lengths

Section of Joint before Putting Pipe Together

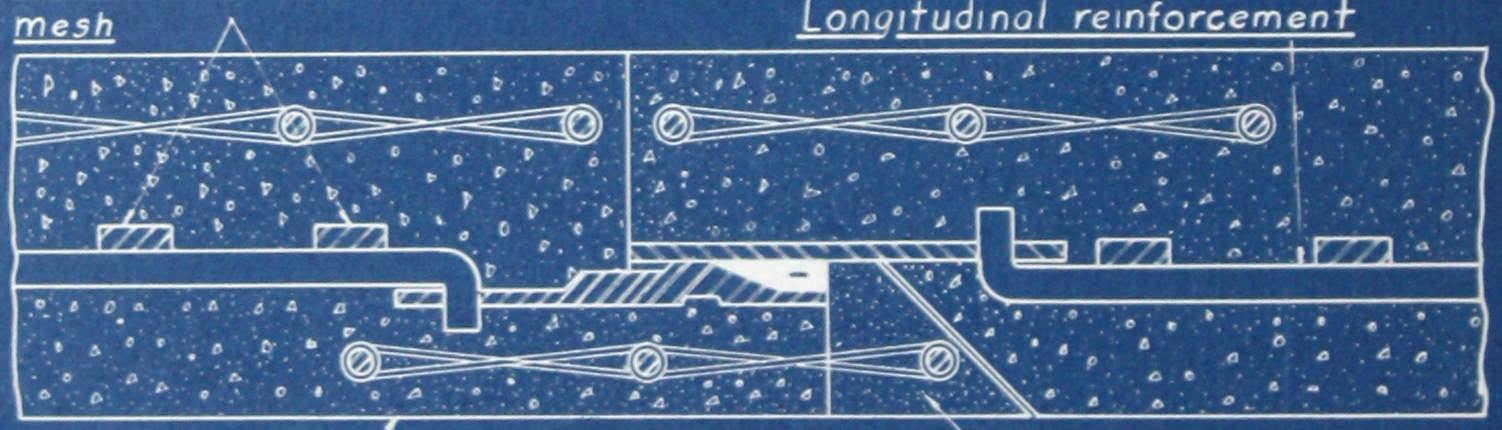


Specially rolled and welded steel protected from corrosion

Fibre filled lead gasket caulked from inside of pipe after backfill has been placed Impossible to blow out

Circumferential reinforcement Varies with pressure Bars or mesh

Longitudinal reinforcement



Inside of pipe

Finished Joint

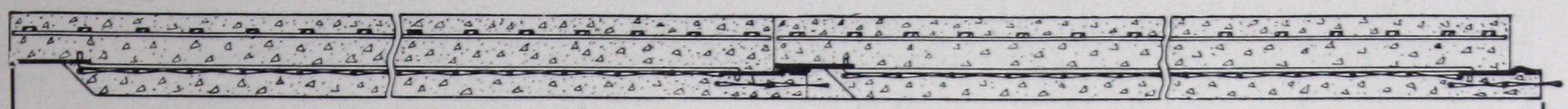
Space filled With mortar to finish interior of pipe line

Lead and Steel Joint Poured Pipe - Sizes 36 to 108"

Patented

LOCK JOINT PIPE Co.

AMPERE N. J.



Lead and Steel Expansion Joint

Protected Steel Ends

IN this type of pipe heavy steel rings are first built into the reinforcement, and then moulded into place in the pipe, forming metal ends. This is shown on blue-print opposite, which illustrates this joint applied to one type of pipe. The bell end consists of a welded ring of flat steel and the spigot end consists of a specially rolled steel section. These joint rings are, of course, completely guarded against corrosion by being embedded in the concrete and by having that portion which may come in contact with water thoroughly protected by being either galvanized or plated with cadmium.

Lead Gasket

Important

When the pipes are placed together and the bell and spigot ends telescope each other, a wedge-shaped cavity, with its large end towards the inside of the pipe, is formed. An endless wedge-shaped, fibre-filled lead gasket is placed in this cavity and is caulked from the *interior of the pipe at any time after the pipe has been laid.* This means that the backfill can be placed on the pipe and the pipe line allowed to settle and assume its natural position before the joints are finally caulked. This is very important.

Smooth Flow-Line

After the lead has been caulked, the interior caulking groove around the circumference of the pipe is filled with trowelled mortar, making a perfectly smooth and continuous flow-line and offering no obstructions to flow whatsoever.

Cannot Blow Out

These joints cannot blow out, as all pressure tends to tighten the wedge.

Flexible

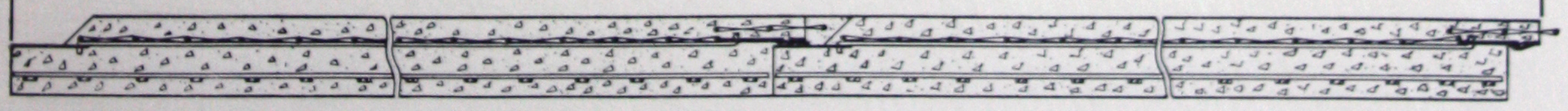
The lead and steel joint is used both for bar pipe and cylinder pipe, is made in sizes from 36 to 108 inches in diameter, is capable of a large amount of expansion and contraction, will care for considerable curvature in the pipe line without having to resort to "specials," and is especially strong, durable, and efficient.

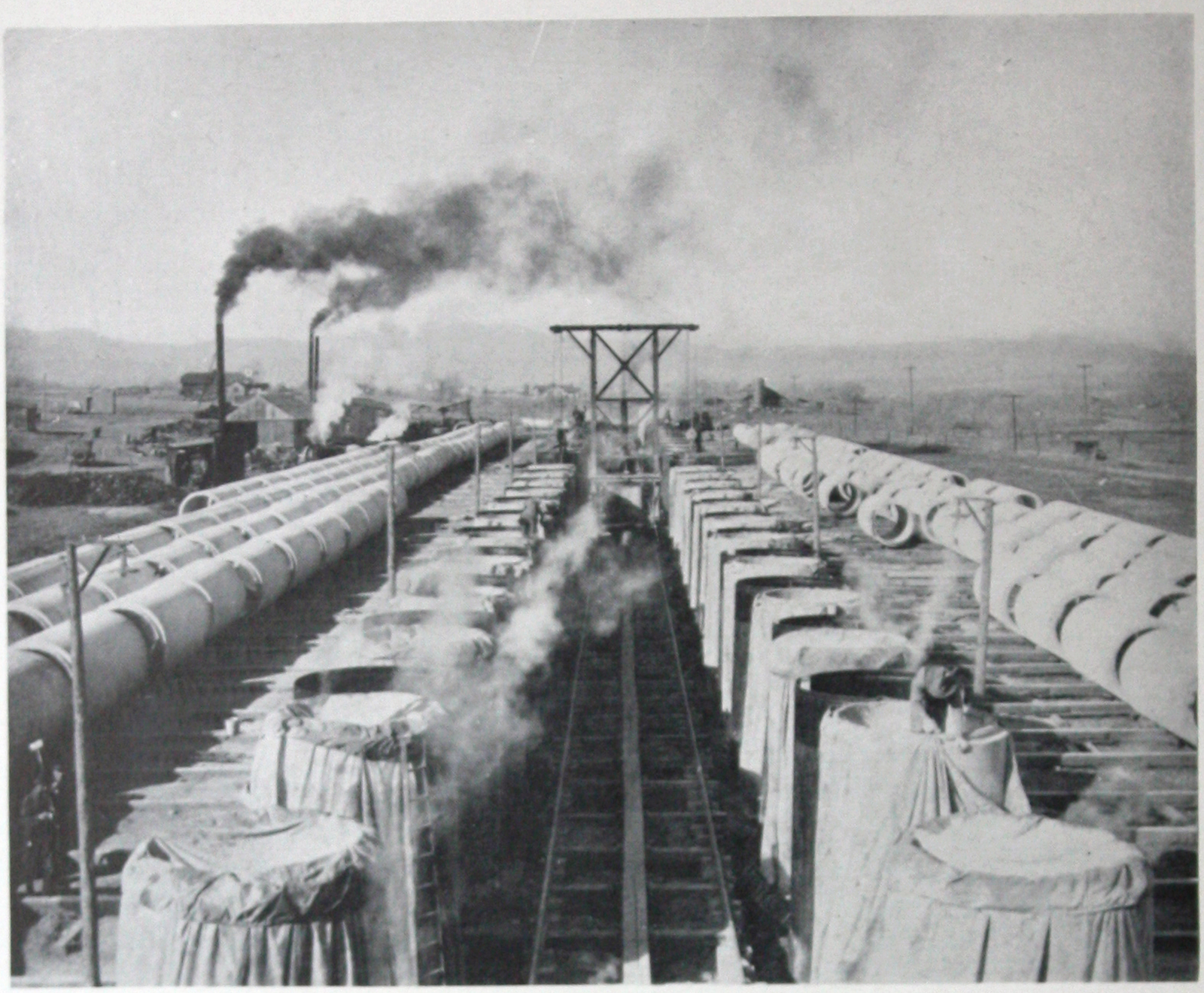
Special Joints

There are certain other types of joints occasionally used for special conditions, which are not described here.

Water in Trench Does Not Affect

Our expansion joints described above are the only joints for large pipe lines which are not adversely affected in the making by the presence of water in the trench. There are no hot materials to get prematurely cold, and there is no soft material to wash out before it sets.





Manufacturing Yard at Fort Logan, Colo. 66-inch Pipe for Denver, Heads up to 188 feet. This Shows the Curing of the Pipes by Steam under Canvas Covers.

Manufacture of Lock Joint Pressure Pipe

Sizes

Lengths

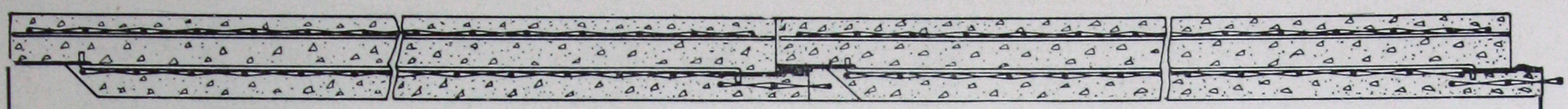
IN general the internal diameter of Lock Joint Pressure Pipe varies from 16 to 108 inches. The pipes are generally made in 12-foot lengths. The larger size pipes are made with the lead and steel expansion joints. The smaller sizes are made with the lead and iron expansion joints.

Forms

True To Shape

Hydraulic Qualities

All forms are made of steel. These are held rigidly in position at the bell and spigot ends of the pipe in such a way that the inner and outer surfaces of the pipe will be truly circular and accurately concentric. The steel reinforcement is held accurately in its proper position in the wall of the pipe. No care or expense is spared on the forms which will produce smoothness and accuracy of shape and alignment, qualities of such vast importance in the hydraulics of pipe lines.



Reinforcement Welded Steel Stresses

The reinforcement varies in amount with the diameter of the pipe and the pressure under which it will operate. It consists of properly fabricated cages of mesh, spirals of mesh, welded bars, or welded steel cylinders, or a combination of these. They are made either in one or two concentric rings, depending on the size of pipe, weight of backfill, or other conditions encountered. The reinforcement is generally figured at from 10,000 to 12,000 pounds per square inch. In designing the reinforcement it is assumed that all the tensile stress is taken by the steel and no value is assumed for tensile strength in the concrete.

Longitudinal Steel

In addition to the circumferential reinforcement, there is also provided ample longitudinal reinforcement, consisting of a variable number of steel bars running lengthwise of the pipe, firmly attached to the cage, and hooked into the joint rings at the ends of the pipe, thereby furnishing ample longitudinal strength and firmly connecting the joint rings at the opposite ends of the pipe.

Concrete

Uniformly strong, dense, water-tight, and smooth concrete is (of course) essential in the pipe walls.

Care

Sand Prepared

The combination of these necessary qualities must be obtained by the most careful selection, preparation and proportioning of the cement, sand, and stone, by thorough mixing, and extreme caution against possible segregation while depositing the concrete in the moulds, and spading and tamping it against the forms and into intimate contact with the reinforcing steel. The sand is oftentimes the controlling factor in the quality of the concrete and in many places the best available sand is not always properly proportioned or well balanced. In such cases it then becomes necessary to crush or roll the sand to obtain a material of the required grading and necessary uniformity from day to day.

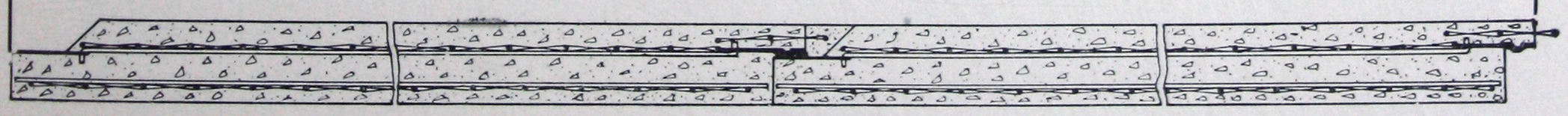
The Mix

The sources, quality, and grading of sand, gravel, or stone available in various parts of the country necessarily prevent the adoption of any arbitrary "mix," but for poured pipe and cylinder pipe this mix approximates 1:1½:2½, and for centrifugal pipes, one of cement and two of sand.

Curing

Storage

Lock Joint Pressure Pipes are cured with the aid of steam, to which they are exposed under canvas covers fitted about the forms. This provides an atmosphere saturated with moisture and at a favorable temperature, and results in the uniform and effective maturing of the pipes in all seasons. After this treatment they are lifted off the cast iron bases, turned on their sides, and are then ready for the storage yard.





Tamping Platform, Ready to Pour Pipe.



Concrete Flowing onto Tamping Platform out of Controllable Bucket.



Poured Pipe

The Forms

Steel Cages and Cylinder

BAR cage pipes, mesh cage pipes, and also cylinder pipes, are made by the poured process. The inner form of smooth steel plates, well oiled, is set up on the base casting made to form the bell end of the pipe. The cages of steel reinforcing and the welded steel cylinder, if there is one, are then placed over the inner form, and the outer form, also of oiled, smooth steel plates, is placed over all of it.

Base Casting

Tamping Platform

Concrete Spaded Around Steel

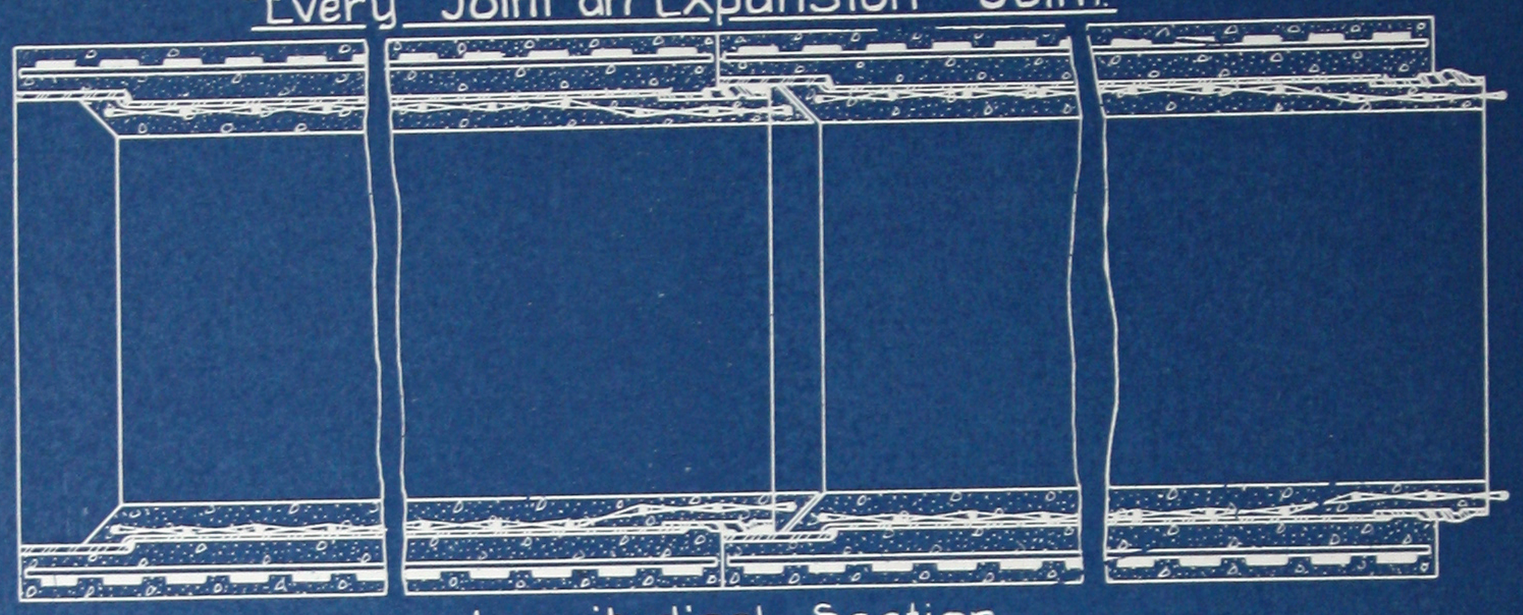
The base casting holds the forms and the reinforcing accurately in proper position at the bell end of the pipe. Upon the top of the forms is placed a tamping platform so designed that it holds the forms and the reinforcing at the top or spigot end of the pipe accurately in their proper positions. The concrete is then poured upon the tamping platform from special controllable buckets, and thence flows into the mould. Then by means of long tamping tools the concrete is spaded carefully into position around all the parts of the reinforcing cages and into perfect contact with the steel forms.

A Desirable Type

This process of pipe manufacture produces very smooth pipe and allows many desirable things to be done which cannot be attained in centrifugal pipe.

One kind of poured pipe is shown on blue-print on next page. Other kinds are illustrated on pages 22, 26, 34, 40 and 41.

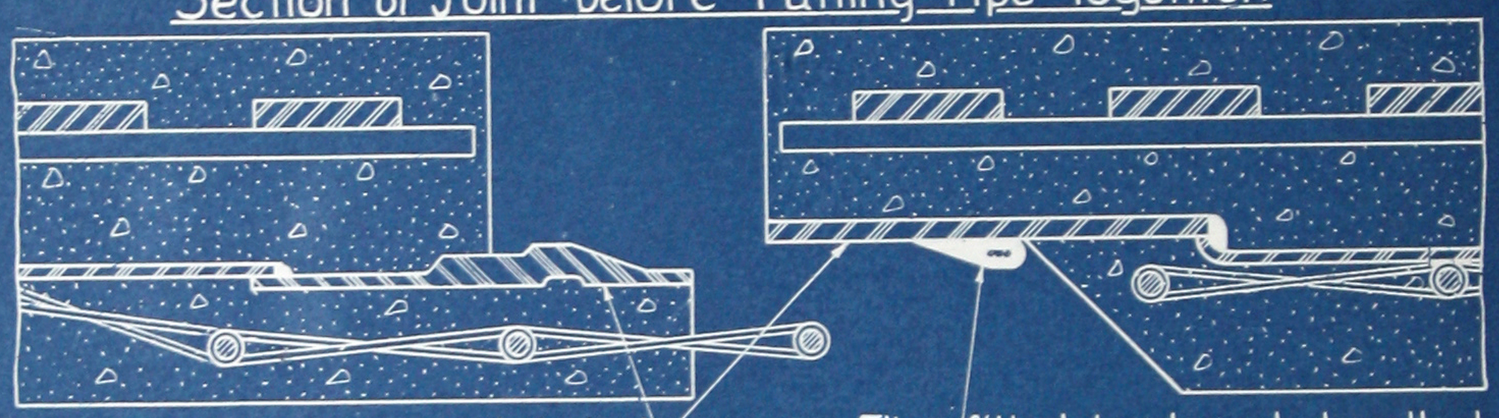
"Every Joint an Expansion Joint."



Longitudinal Section.

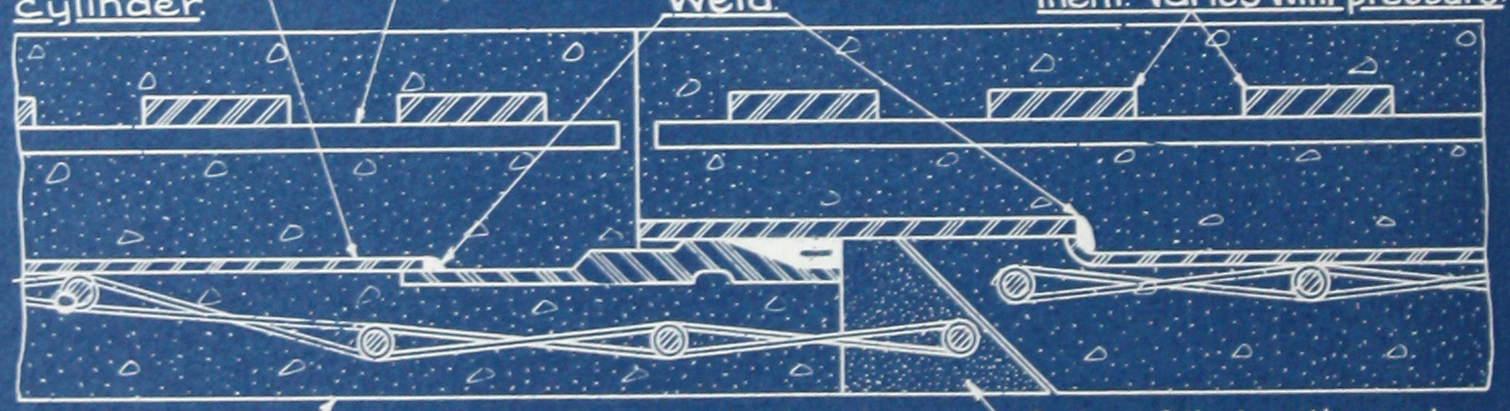
Pipes Made in 8' to 12' Lengths.

Section of Joint before Putting Pipe Together.



Specially rolled and welded steel, protected from corrosion.

Fibre filled lead gasket caulked from inside of pipe after backfill has been placed. Impossible to blow out.



Lead and Steel Joint with Welded Steel Cylinder. - Sizes 36" to 108"

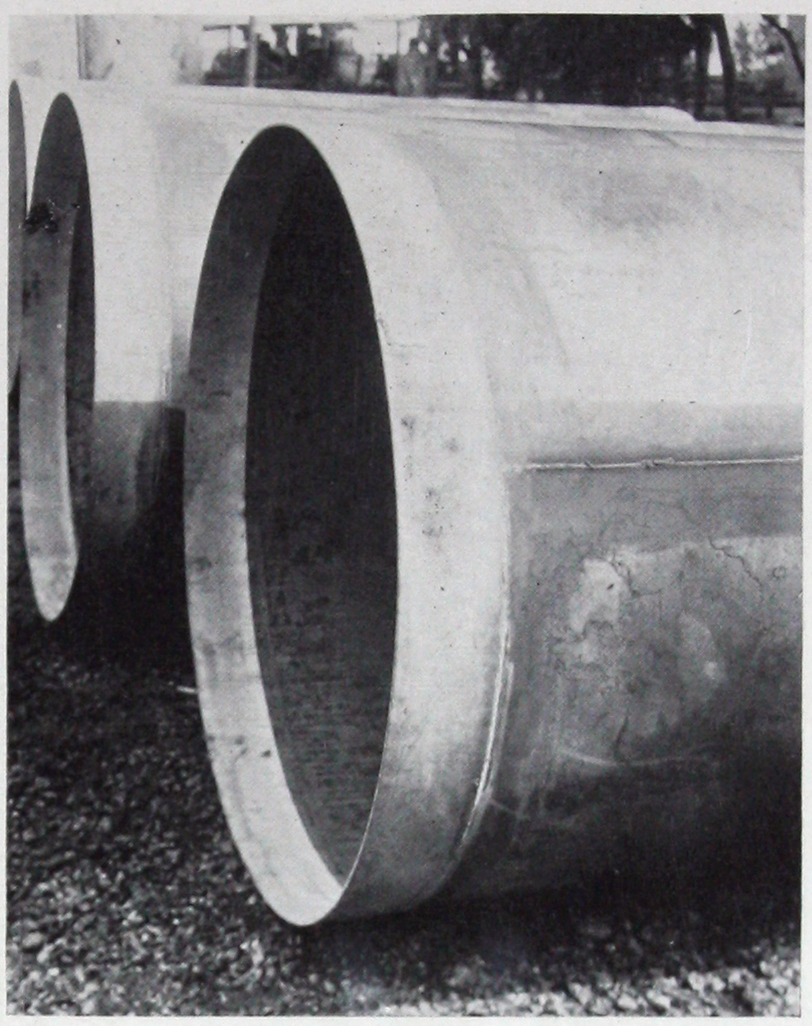
Patented

LOCK JOINT PIPE Co.

AMPERE, N. J.



Steel Spigot Ring Welded to Sheet Steel Cylinder.



Steel Bell Ring Welded to Sheet Steel Cylinder.

These Cylinders are Ready to be Built into the 48-inch Pipe for the First High Service Line at Washington, D. C.

Cylinder Pipe

Welded Steel Cylinder

THIS type of pipe is used for the higher heads and is made by forming a steel cylinder of the proper size and dimensions, welding it along all of its seams, and securely attaching the cylinder, either by welding or by mechanical means, to the joint rings, and then encasing the entire cylinder, both inside and outside, with reinforced concrete.

Tested

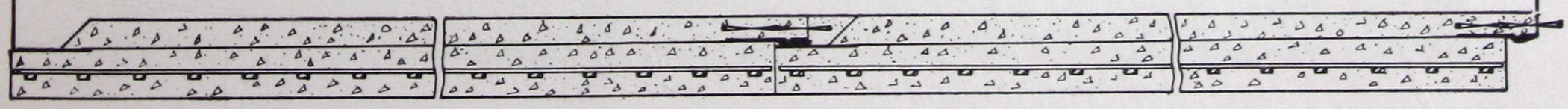
After the joint rings are attached at the ends, and the welding is completed, the steel cylinder is put under a test for tightness by means of compressed air. This test is made under an air pressure which puts the cylinder under the same stress it will have in service in the pipe line.

Cylinder pipe is used both with the lead and iron expansion joint and with the lead and steel expansion joint.

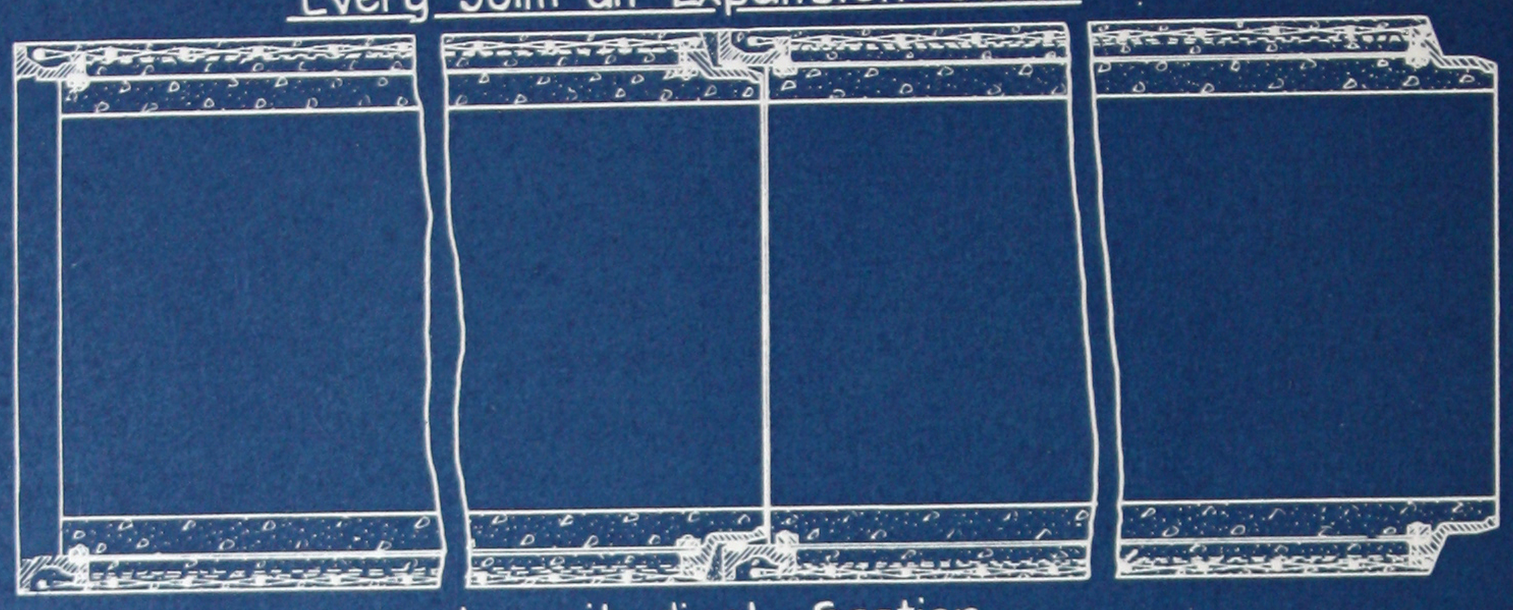
Reinforcement

Tight

The steel cylinder is figured as reinforcement, and whatever reinforcement is needed in addition to the steel cylinder, is provided in the shape of hoops of welded bars, in the concrete on the outside of the cylinder. This type of construction makes a very dur-



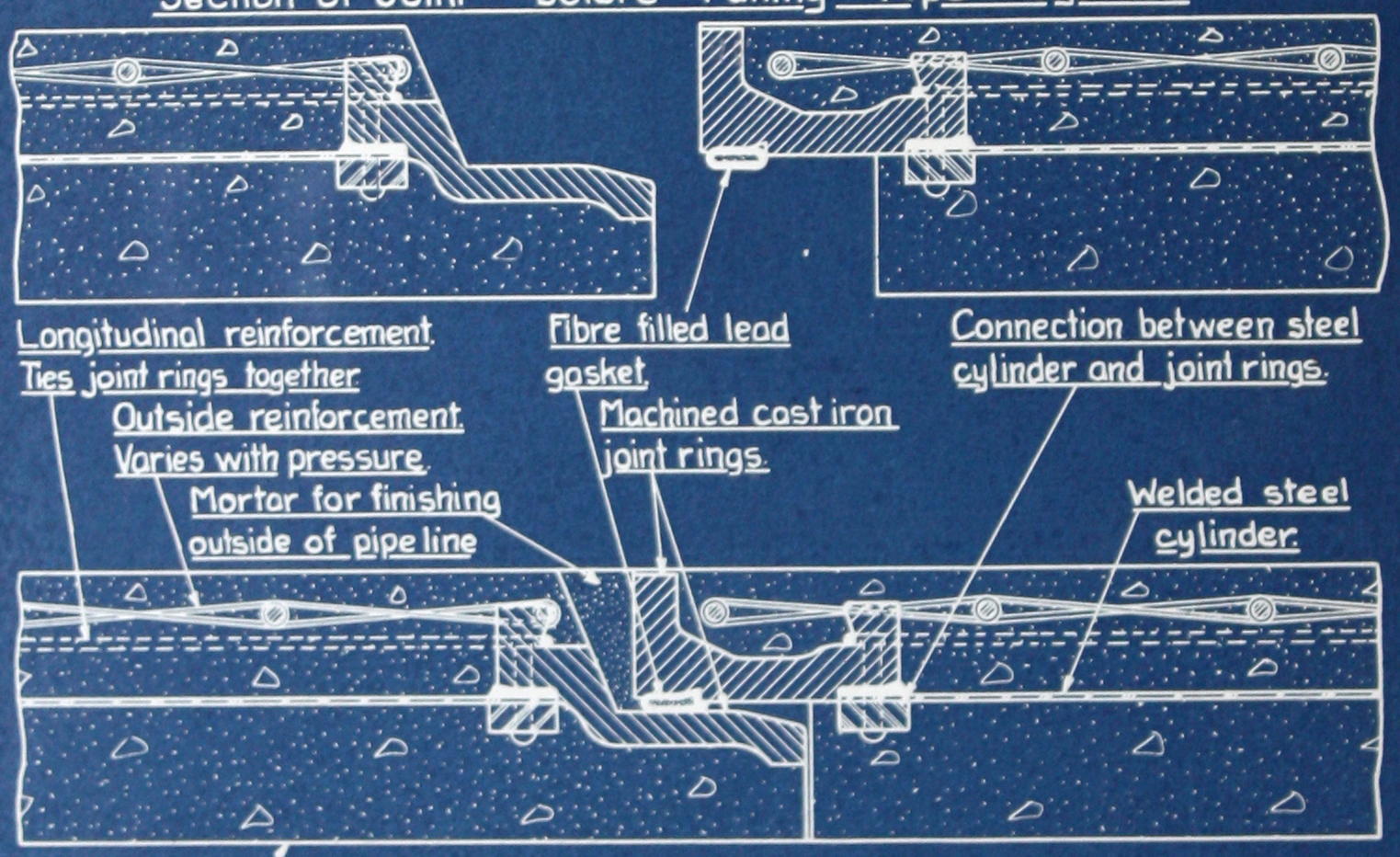
"Every Joint an Expansion Joint."



Longitudinal Section.

Standard Length 12 Feet.

Section of Joint before Putting Pipe Together.



Finished Joint.

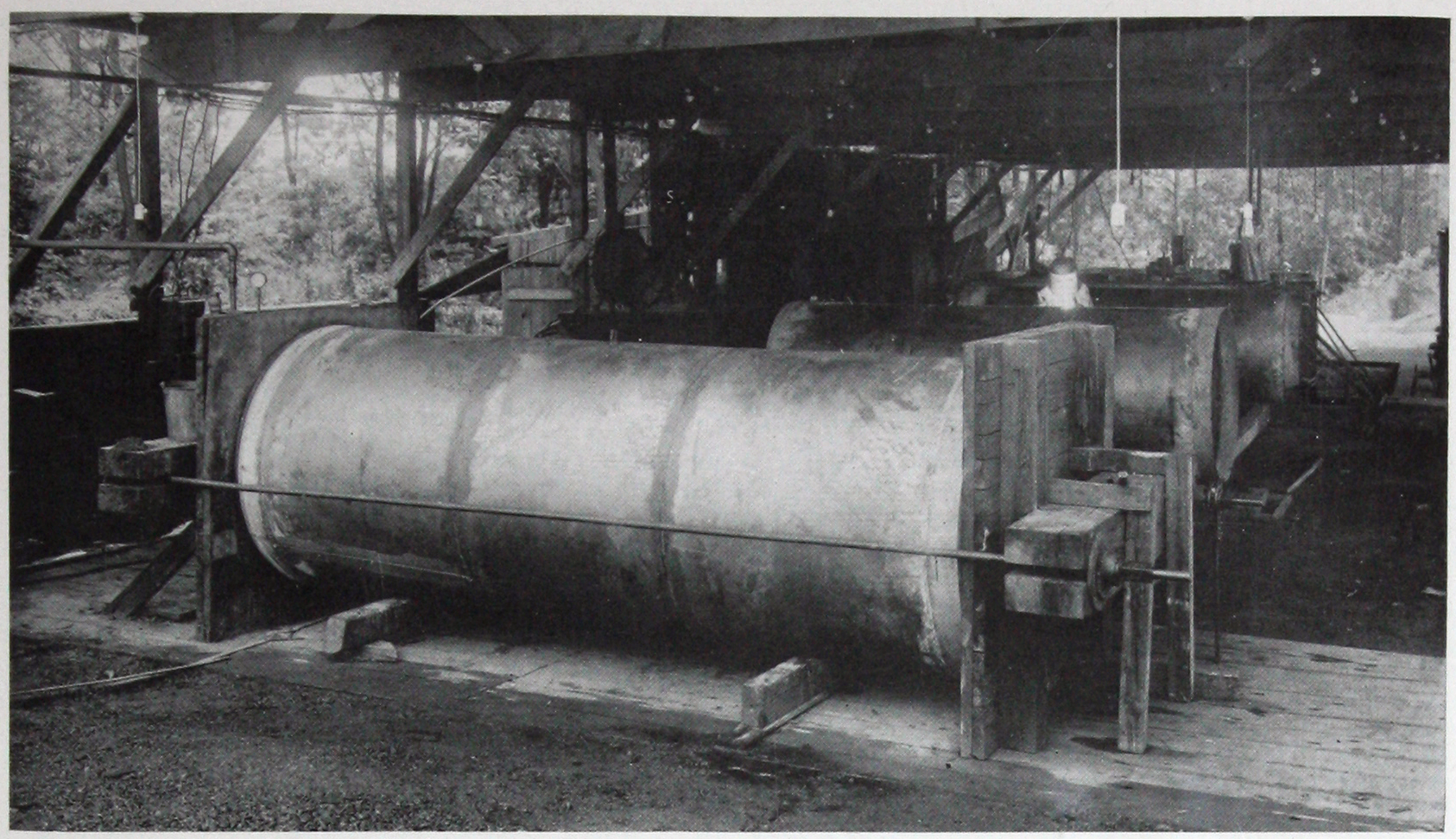
Joints are made by forcing cone shaped end of spigot thru' annular fibre filled lead gasket until gasket lies compressed and radially caulked between the two parallel surfaces. These joints will take care of a large amount of expansion, contraction and settlement.

Lead and Iron Self-caulking Joint with Welded Steel Cylinder - Sizes 12" to 48"

Patented.

This joint may be used with orwithout steel cylinder.

LOCK JOINT PIPE Co.
AMPERE, N.J.



Testing Cylinders with Air Pressure.

Permanent

able and tight pipe line, the steel cylinder being entirely embedded in concrete and therefore protected from corrosion, at the same time serving to prevent leakage on the high heads.

Expansion and Contraction

The same amount of expansion and contraction is provided for in the joints of these pipes as in the other pipes which we make, and the method of laying pipes is the same. There is no field riveting done in the ditch.

Proven

Pipes of this character have been in successful use for a period of over 50 years. They are used for pressures ranging up to 400 feet. One kind of cylinder pipe is shown on blue-print opposite. Another is shown on page 32.

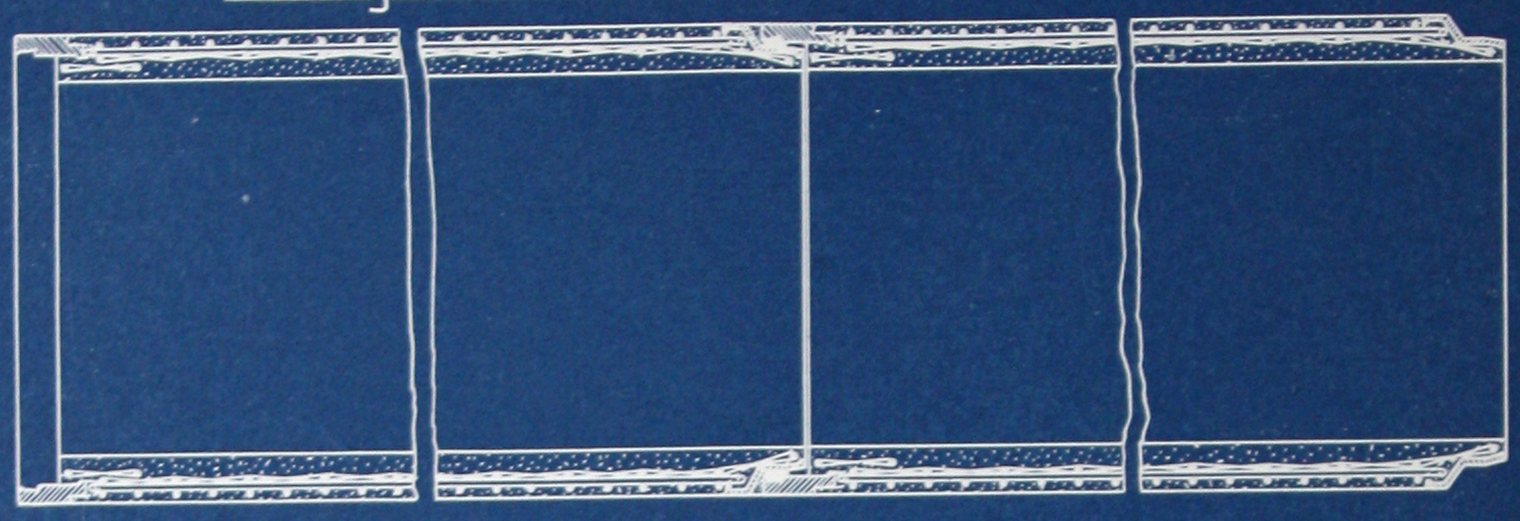
Centrifugal Pipes

Whirled

Dense

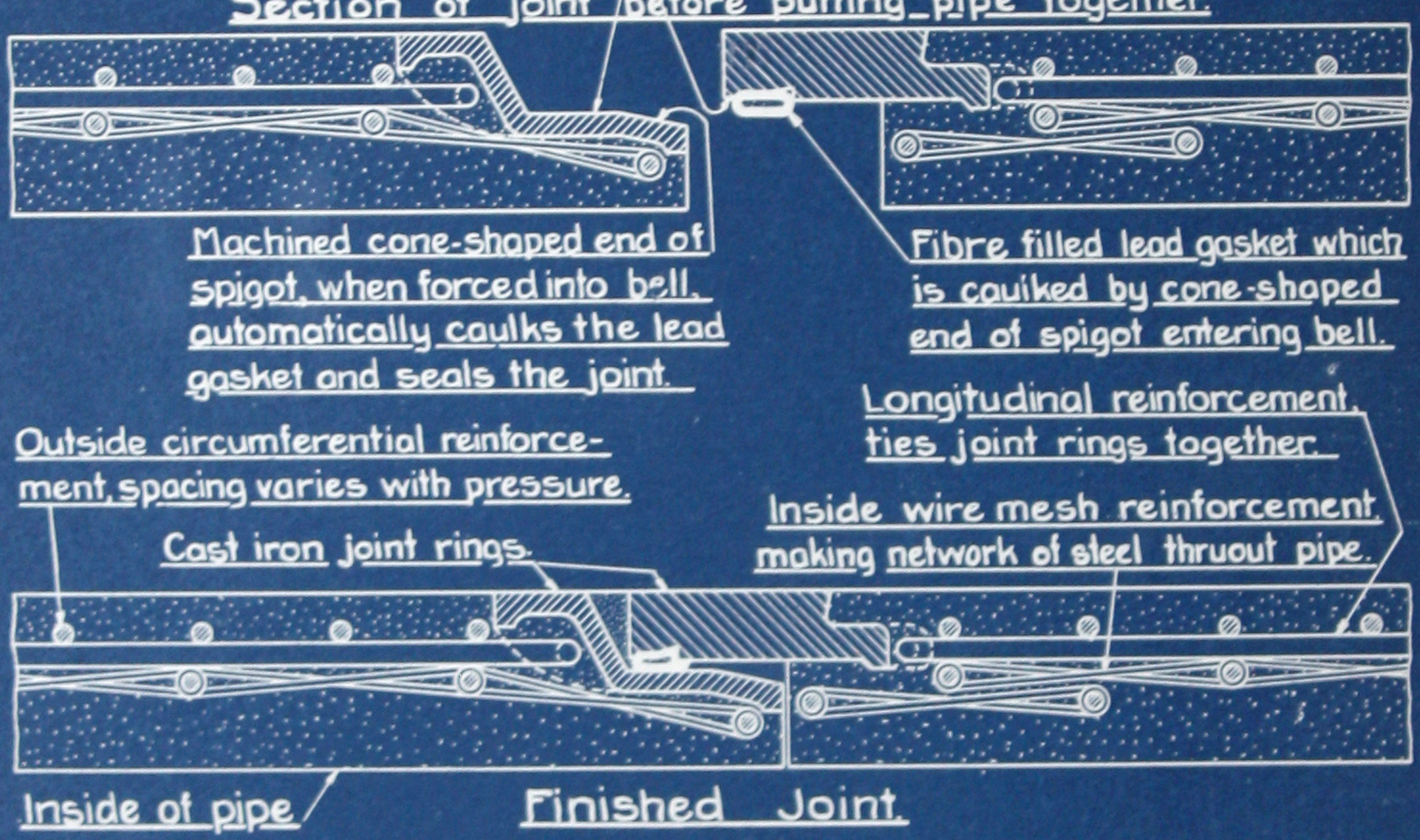
THE centrifugal process of making reinforced concrete pressure pipe involves the rapid rotation of an outside mould, into which has been placed a pre-determined amount of plastic mortar or concrete. The mould is spun at high speed and as a result of the centrifugal force thus set up, the concrete is thrown outwardly against the inner face of the mould and becomes a very thoroughly compacted and dense mass.

"Every Joint an Expansion Joint."



Longitudinal Section.

Standard Length 12 Feet.

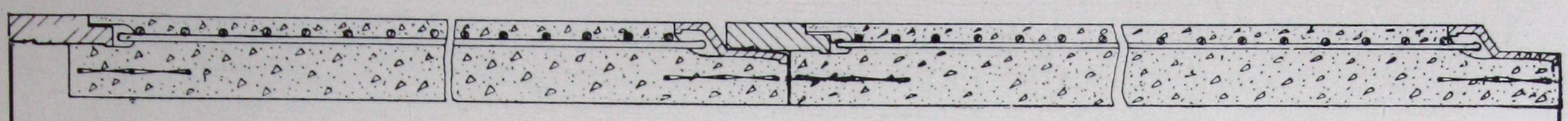


Finished Joint.

Centrifugally made reinforced concrete pressure pipe with lead and iron self-caulking expansion joint.

Patented.

LOCK JOINT PIPE Co.
AMPERE N. J.



Laitance

During the whirling process, the laitance and a large portion of the water in the mix comes to the interior surface of the pipe. This must be removed in order to get a smooth, hard interior surface.

Evenly Distributed

In order to get an even distribution of the concrete along the entire length of the pipe, which is 12 feet, the concrete is placed in the mould while it is spinning. It is first put into a long pipe-shaped bucket which is introduced through one end of the mould.

Time

This bucket is then turned over so that its contents are gradually discharged in a ribbon, 12 feet wide, on the inside surface of the rotating mould. After a suitable period of rotation, the mould, with the pipe in it, is removed from the centrifugal machine and put in the storage yard for the pipe to cure. After about 12 hours the moulds are removed and assembled again for another pipe.

Ideal

The lead and iron expansion joint has been accommodated to the centrifugal pipes, and the combination of the increased density of centrifugal concrete and our lead and iron expansion joint make this an ideal pipe for water supply where moderate size pipes are required. This joint is shown on the blue-print on opposite page.

Sizes

These pipes are furnished in sizes 16 to 36 inches in diameter.

Steel Reinforcement

The steel reinforcement for the centrifugal pipe is commonly made by winding heavy wire into a cage of suitable dimensions and weight, combined with wire mesh. The wire is wound in spiral form by a machine, which spaces it automatically, as indicated by the illustration opposite.

Excellent

The joint rings, which make expansion joints, are firmly attached to the reinforcement. When the reinforcement and joint rings are embedded in centrifugal concrete, a most excellent pressure pipe results, which has great strength, flexibility, and carrying capacity.

Careful Selection

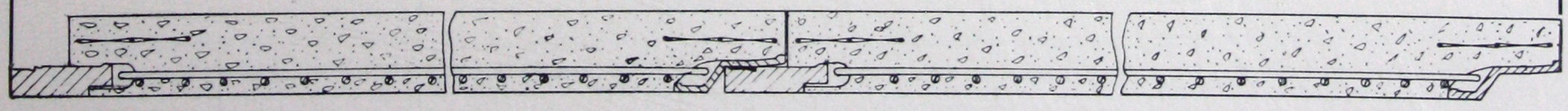
It must not be assumed that any materials which could ordinarily be used for concrete will make good centrifugal concrete, for such is not the case. The most careful selection is necessary.

"*EVERY JOINT AN EXPANSION JOINT.*" No Tuberculation — no loss in Carrying Capacity. When the pipe is laid the joint is made.

Laying

Not Held Up

THE laying of a Lock Joint Pressure Pipe Line differs from other lines in that no operation is held back on account of the joint making. In the case of the lead-iron expansion joint, the joint is automatically finished complete and permanent as the pipe is laid. In the case of the lead-steel expansion joint for large size pipe, no other operation is held up, because the joint is made from the interior of the pipe line after it is backfilled and the surface over the trench opened for traffic.

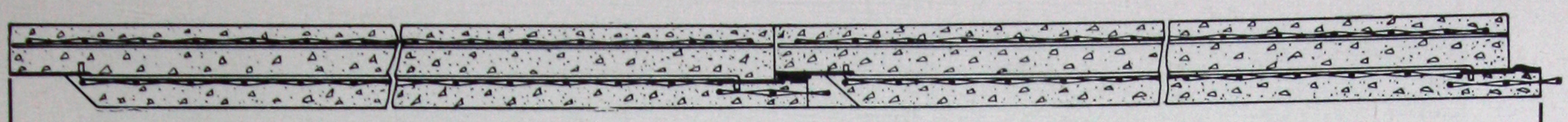




A Curve without Specials in the 66-inch Denver Pipe Line.



Swinging a 9-ton Length of 66-inch Pipe into the Trench.



No Bell Holes

No bell holes are required. Sheeting and pumping are kept down to a minimum because the joint can be made, and made as good as otherwise, with water in the ditch. These features alone aid very materially the speedy construction of the pipe line. We have repeatedly laid, with one crew of men, from 750 to 1,000 feet of pipe line, of diameters as large as 66 inches, in one working day.

Speed

Curves In Line

The flexibility of the lead and steel and the lead and iron expansion joint permits the standard 12-foot lengths to be laid on most of the vertical and horizontal curves met with in water supply lines. The following figures give certain radii of curvature which can be attained in this way.

Limiting Radii

For standard 12-foot lengths of pipe and for diameters of pipe as follows: *Inches*	*Radius of curvature cannot be less than about* *Feet*
36	675
42	785
48	885
54	990
60	1100
66	1165
72	1310
78	1415
84	1515
90	1615

Short Radius Curves

Where it is necessary to lay a line with a curve of shorter radius than above indicated, in special cases the pipes may be cast in shorter lengths or they may be made with the spigot end set at a slight angle. Sharp bends are frequently made by bringing the two tangents of the line to an intersection and there building a heavy monolith of reinforced concrete. This method eliminates the need for expensive specials and greatly facilitates the layout of the line, as the bend can be built to any angle and made to fit the best line location. A monolithic bend is cast against the trench walls and therefore serves to withstand effectively the unbalanced pressure load at the bend.

Bends

Branches

No trouble is encountered in providing for branch lines, manholes, air valves, blowoffs, gate valves, etc.

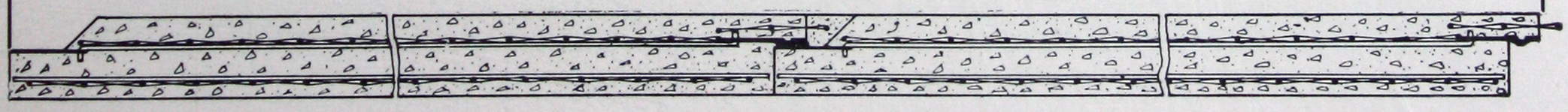
Specials

Special castings are securely moulded into the pipe walls or ends, as the case may be, and made to fit with a bell or spigot, flange or threaded connection.

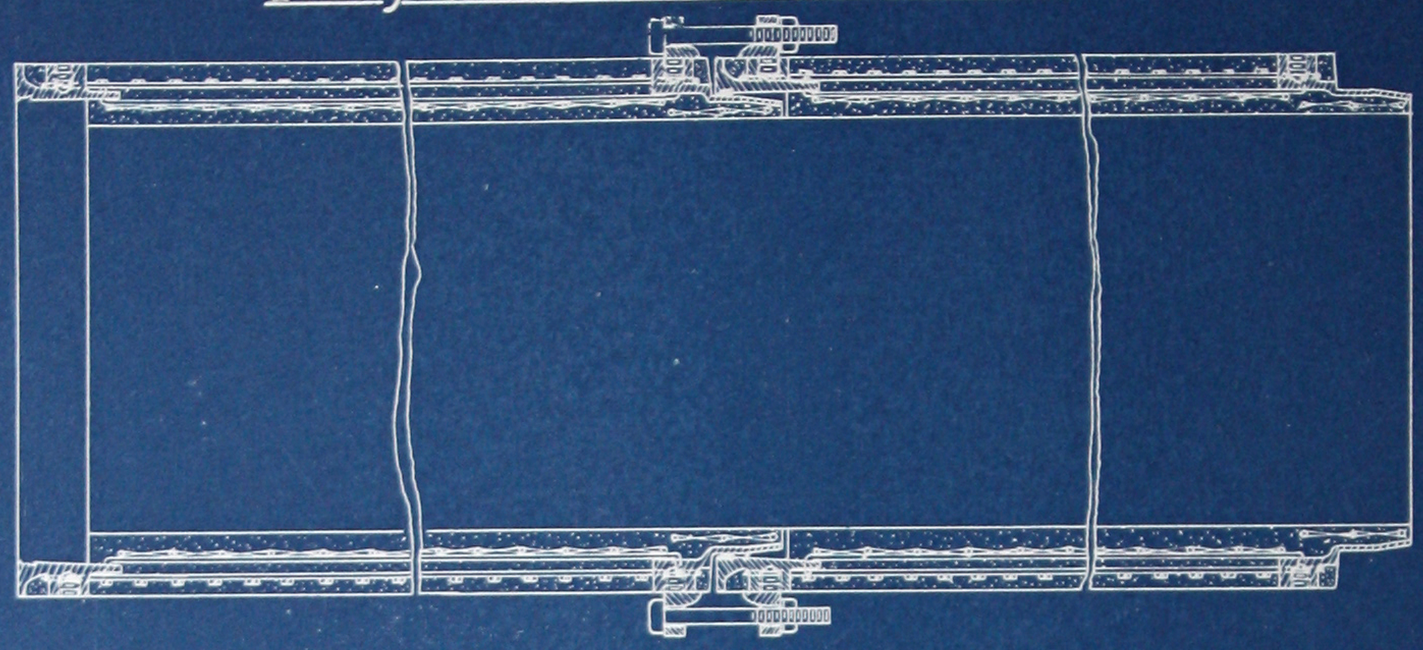
Any specials used in Water Works Construction can be made.

Small Connections

Special fittings may be moulded into the wall of the pipe to permit the connection of small pipe, such as service pipe, without taking the pressure off the large main.

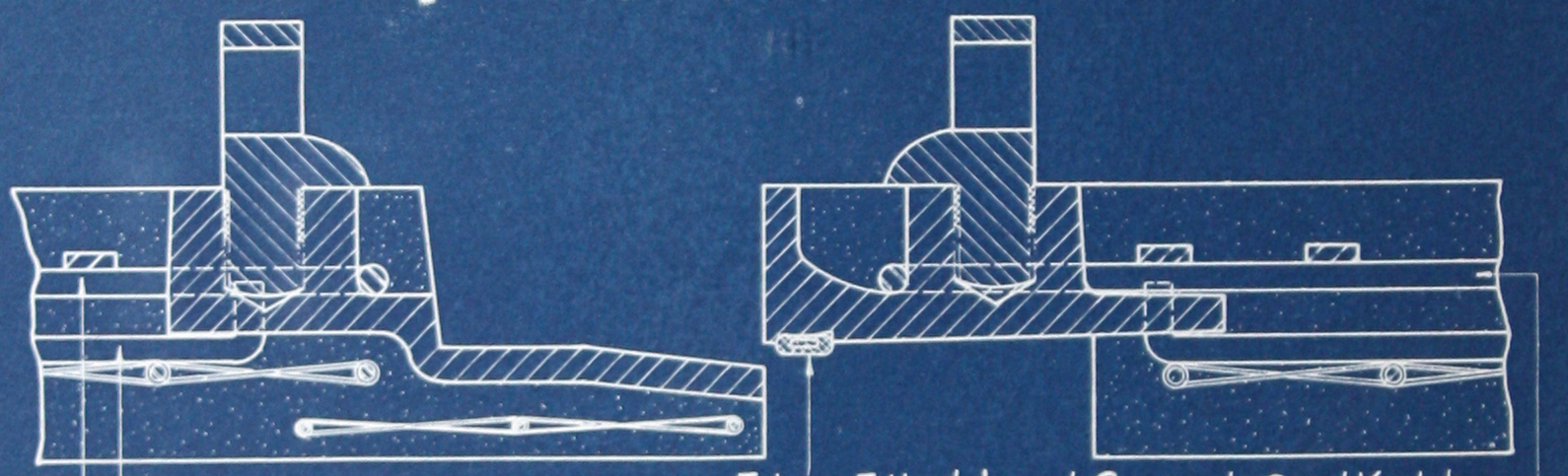


"Every Joint a Flexible Joint"



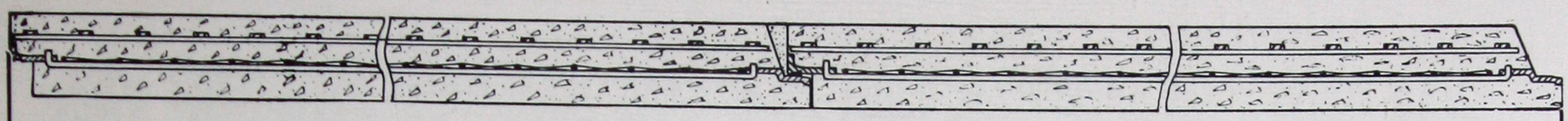
Longitudinal Section
Standard Length 12 Feet

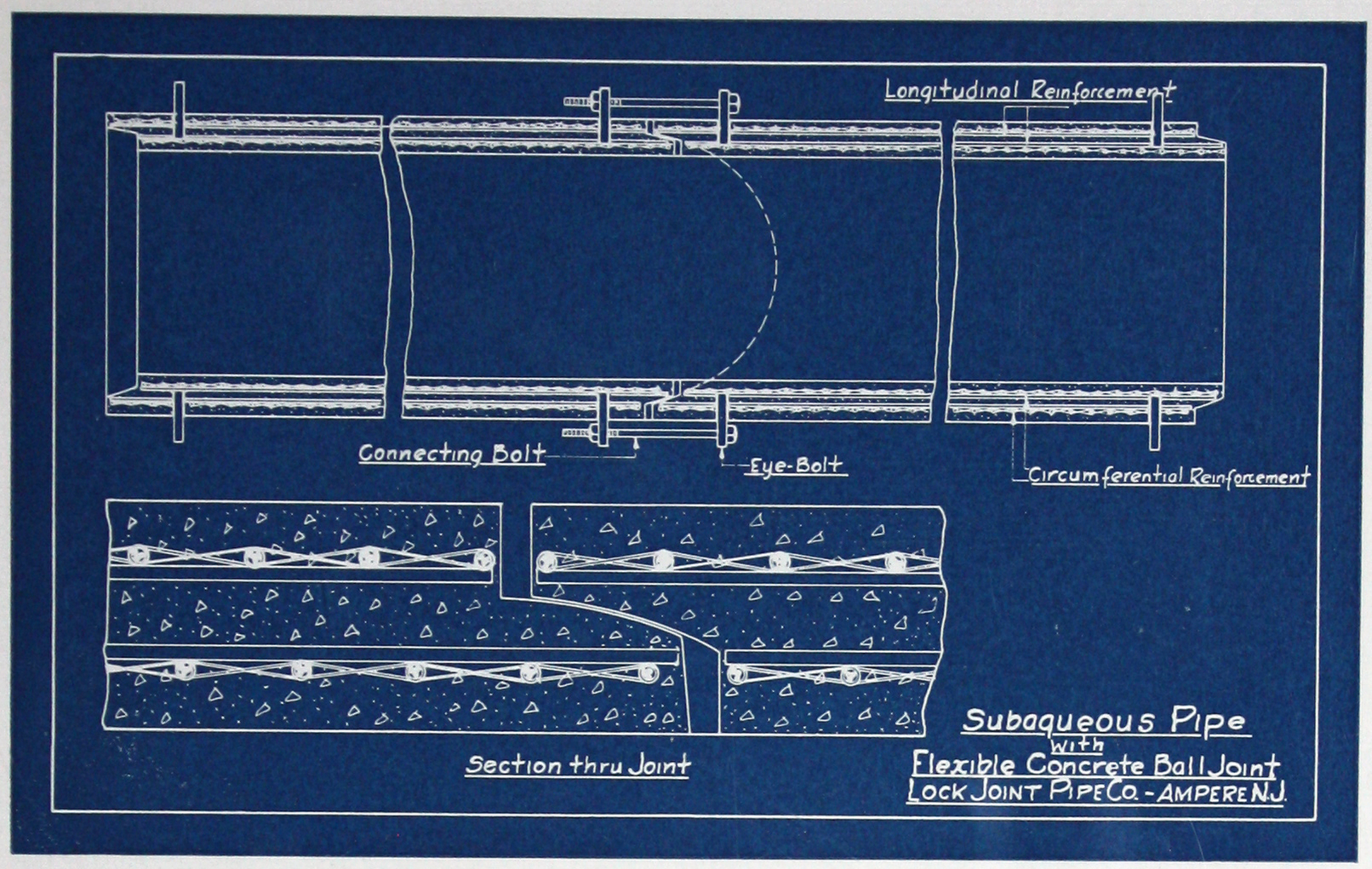
Section of Joint before putting Pipe Together



Subaqueous Reinforced Concrete Pressure Pipe with Lead and Iron Self Caulking Flexible Joint

LOCK JOINT PIPE CO.
AMPERE N.J.





Subaqueous Pipes

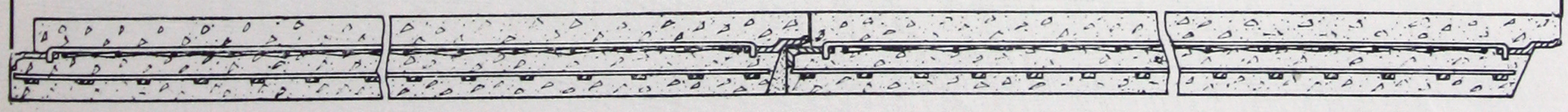
Water Intakes and Sewer Outfalls

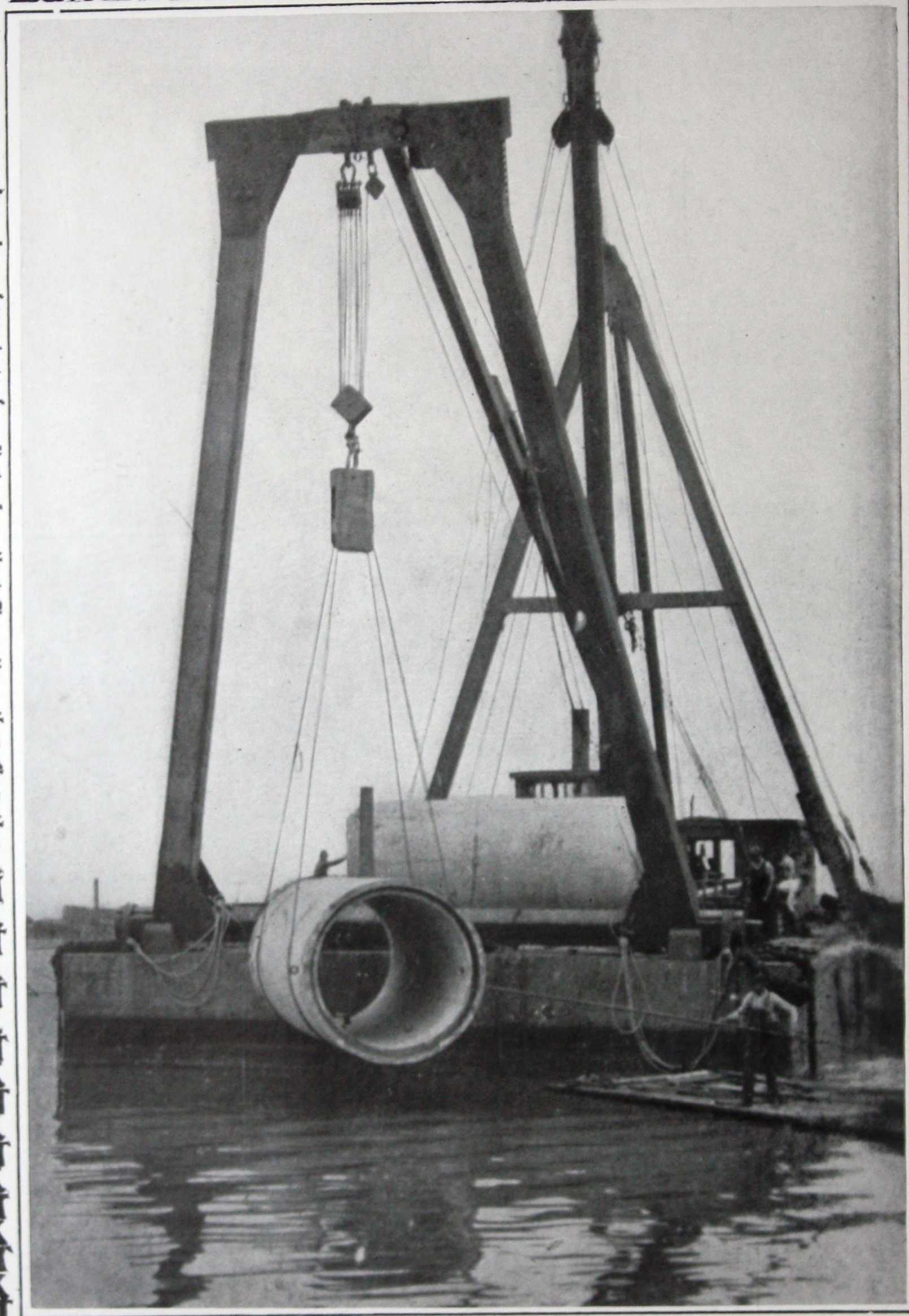
LOCK Joint Reinforced Concrete Pipe is especially well adapted to subaqueous lines used as intakes or outfalls. Pipe for this purpose is generally made in lengths of 12 to 20 feet. Joints of special design for subaqueous pipe are shown herewith. The one opposite is suitable for use where conditions demand the greatest degree of water-tightness in the line. The one above is suitable for situations where reasonable tightness is required, but not necessarily the most perfect tightness obtainable, as for example, in a subaqueous sewer outfall.

Special Joints

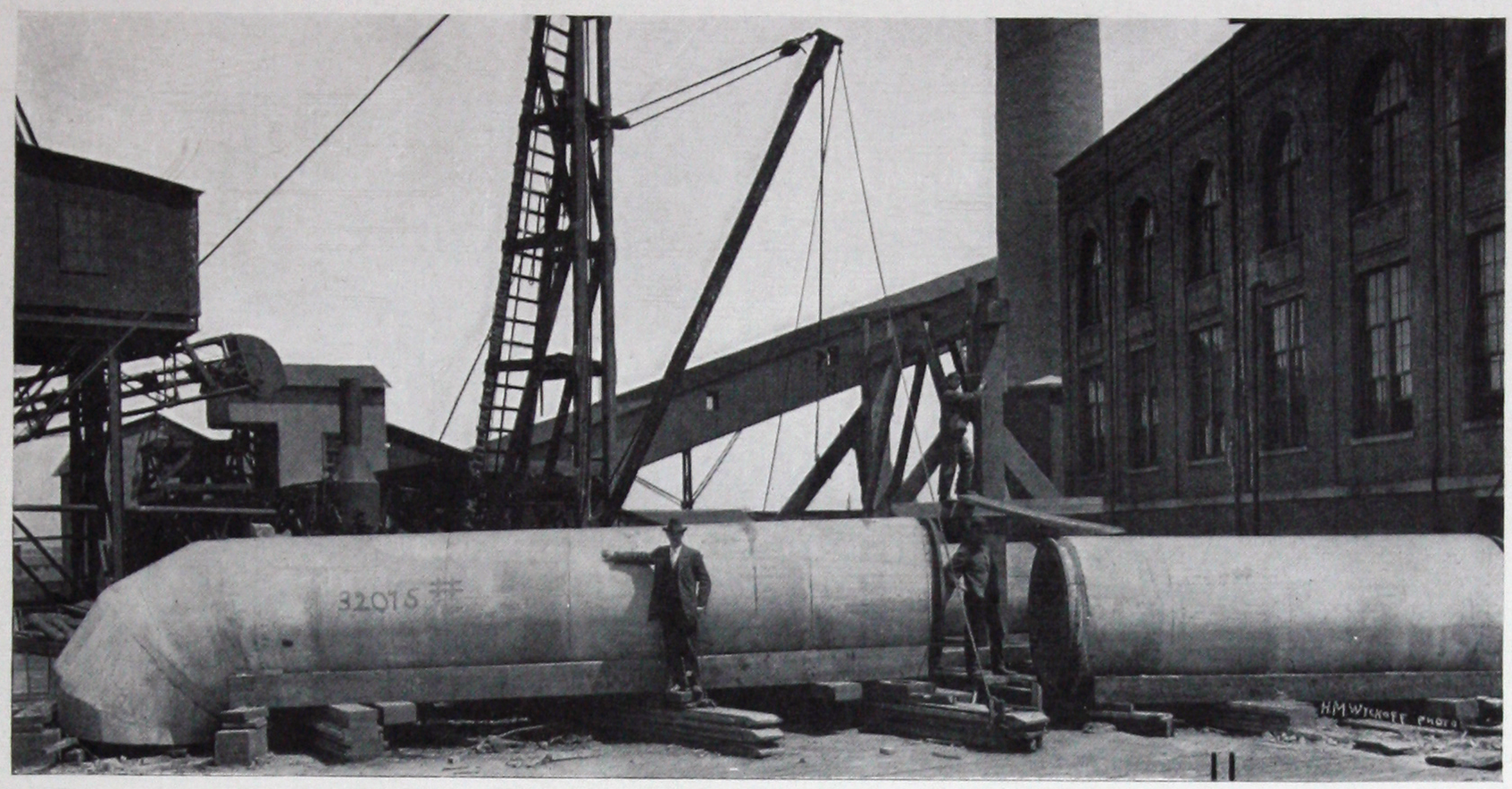
Under Water Work a Minimum

Lock Joint Subaqueous Pipes have been used in both fresh and salt water, and no deterioration has been observed in such use. The pipe joints are designed so that a minimum of work will have to be done under water. Lock Joint Pipes for Subaqueous work have been laid in such widely separated points as St. Lambert, Que.; Portland, Me.; Cleveland, Ohio; Brooklyn, N. Y.; Denver, Colo.; Baltimore, Md.; Perth Amboy, N. J.; and Jersey City, N. J. In every one of these cases this pipe has given complete satisfaction.





Laying 84-inch Subaqueous Sewer Outfall at Cleveland, Ohio.



Some Other Lock Joint Advantages

Made In Your Own City

LOCK Joint Pressure Pipe is usually manufactured on a site close to where it is to be used, employing local labor, local materials, etc., as far as possible, a very decided advantage to the community using it.

Laying Made Rapid and Safe

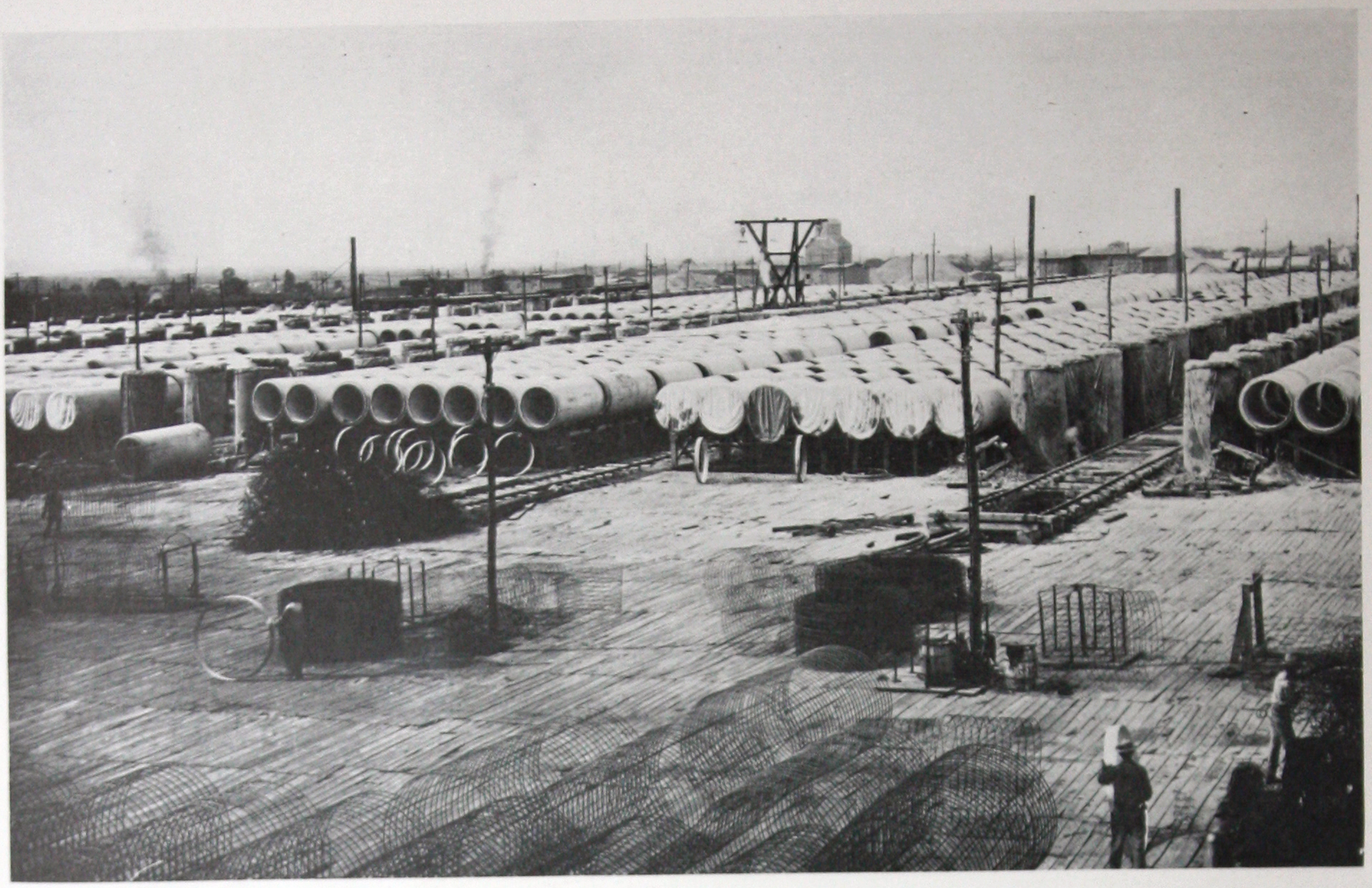
The design of the pipe and joints, and the method of laying, enable the pipe line to be laid rapidly, and to get the ditch refilled in the shortest possible time. This results in greater safety in construction, greater economy, and reduces the risk of imperfect work and possible damage resulting from difficult ditch conditions, such as water, quicksand, etc.

Low Cost, Maintenance and Repairs

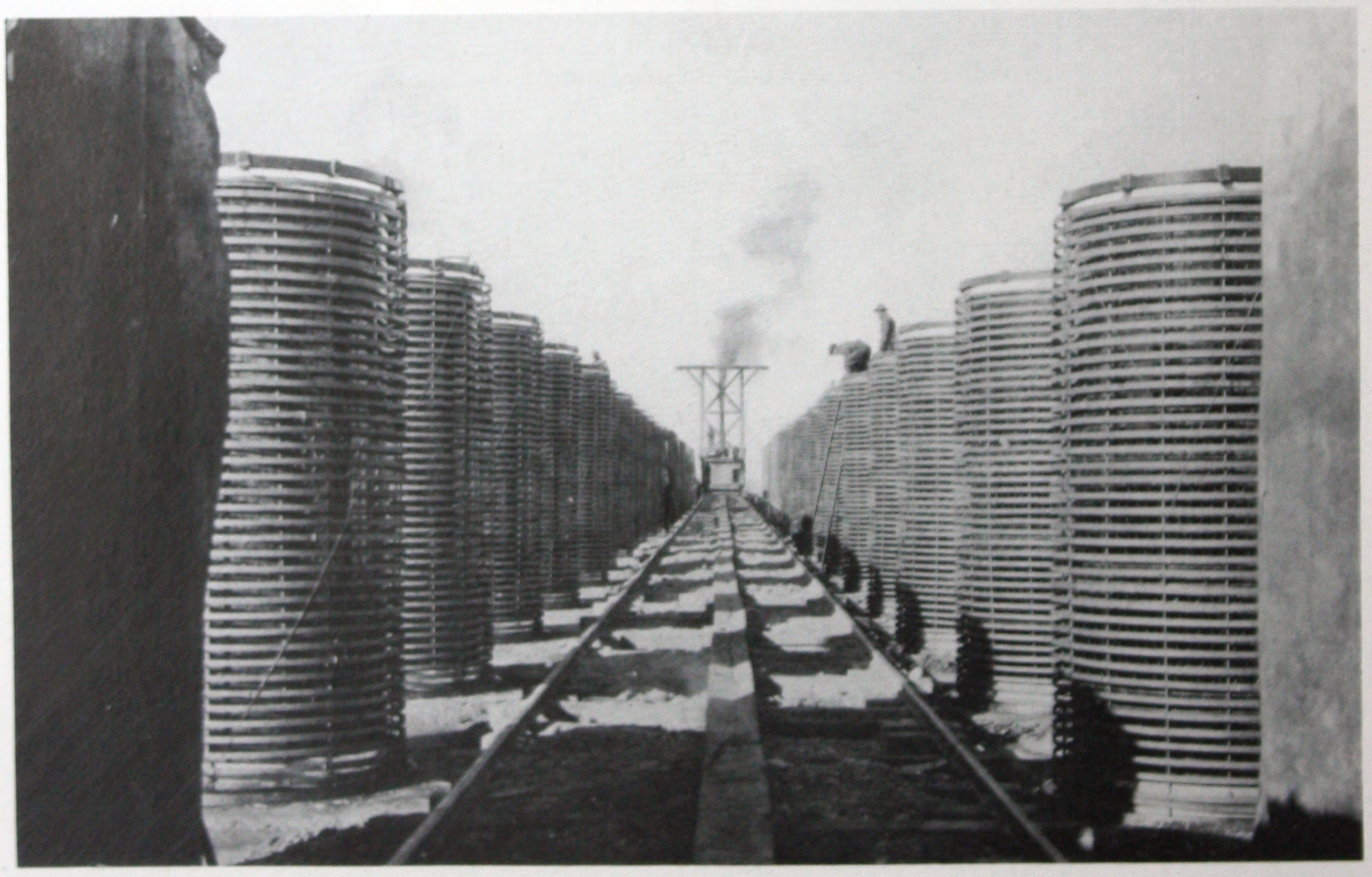
We know of very few expenditures being made by owners of Lock Joint pipe lines for maintenance and repairs after the line has been turned over to them by us, and we confidently believe that the upkeep cost of a Lock Joint Pipe Line is equally as low as of any other type of pipe.

Guarantees

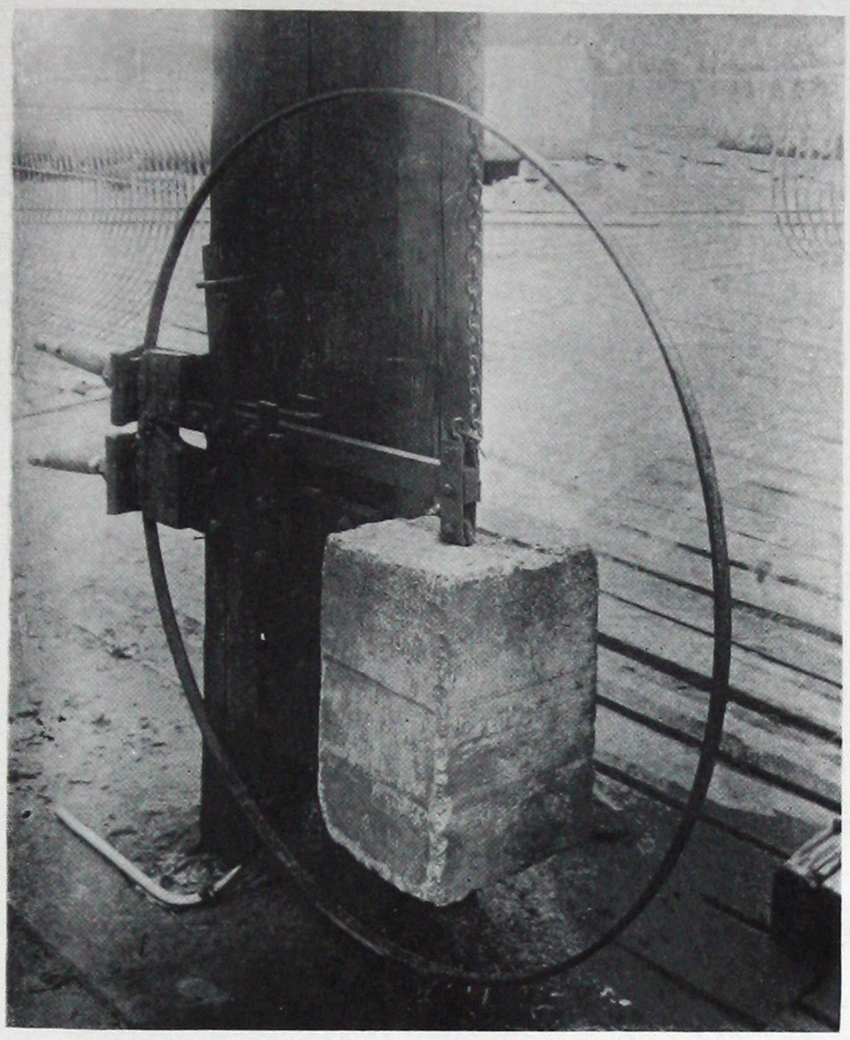
The reputation of the Lock Joint Pipe Company has been built up by giving the most painstaking care to the work entrusted to it. Suitable and reasonable guarantees as to the quality of Lock Joint Pipe Lines are always offered. Such guarantees generally relate to Maximum Leakage in the completed pipe line and Maintenance for a year after the completion of the pipe line. The Lock Joint Pipe Company has never failed to fulfill every requirement of every contract entered into.



Manufacturing and Storage Yard Showing Fabrication of Wire Mesh Cages in Foreground.



Heavy Reinforcement Set-Ready for Outside Forms.



All Welds are Tested.

The Cost of a Lock Joint Pipe Line

To Transport Water

THE only excuse for a pipe line is to transport water. The most economical pipe line is therefore the one which will transport the greatest quantity of water and keep on doing it.

Most Economical Pipe Line

While a Lock Joint Pipe Line is very often the lowest in first cost, it is almost always the most economical when the combination of carrying capacity and long life is considered.

Carrying Capacity and Durability Are Factors

Many prominent engineers give practical consideration to these features, and the United States Engineer's Office in Washington, D. C., in writing their specifications for pipe lines to serve the Capital City, have allowed a life for reinforced concrete pipe line equal to the longest life usually allowed for any other kind of pipe, and have also allowed a carrying capacity approximately 30% more than that allowed for metal pipes.

The Lock Joint Pipe Company offers permanently high carrying capacity in a permanent pipe line.

DISCHARGE FOR "LOCK JOINT" PIPE

VALUES OF COEFFICIENT "C" IN WILLIAMS-HAZEN FORMULA & OF "N" IN KUTTER'S, CORRESPONDING TO $C_S = 0.360$

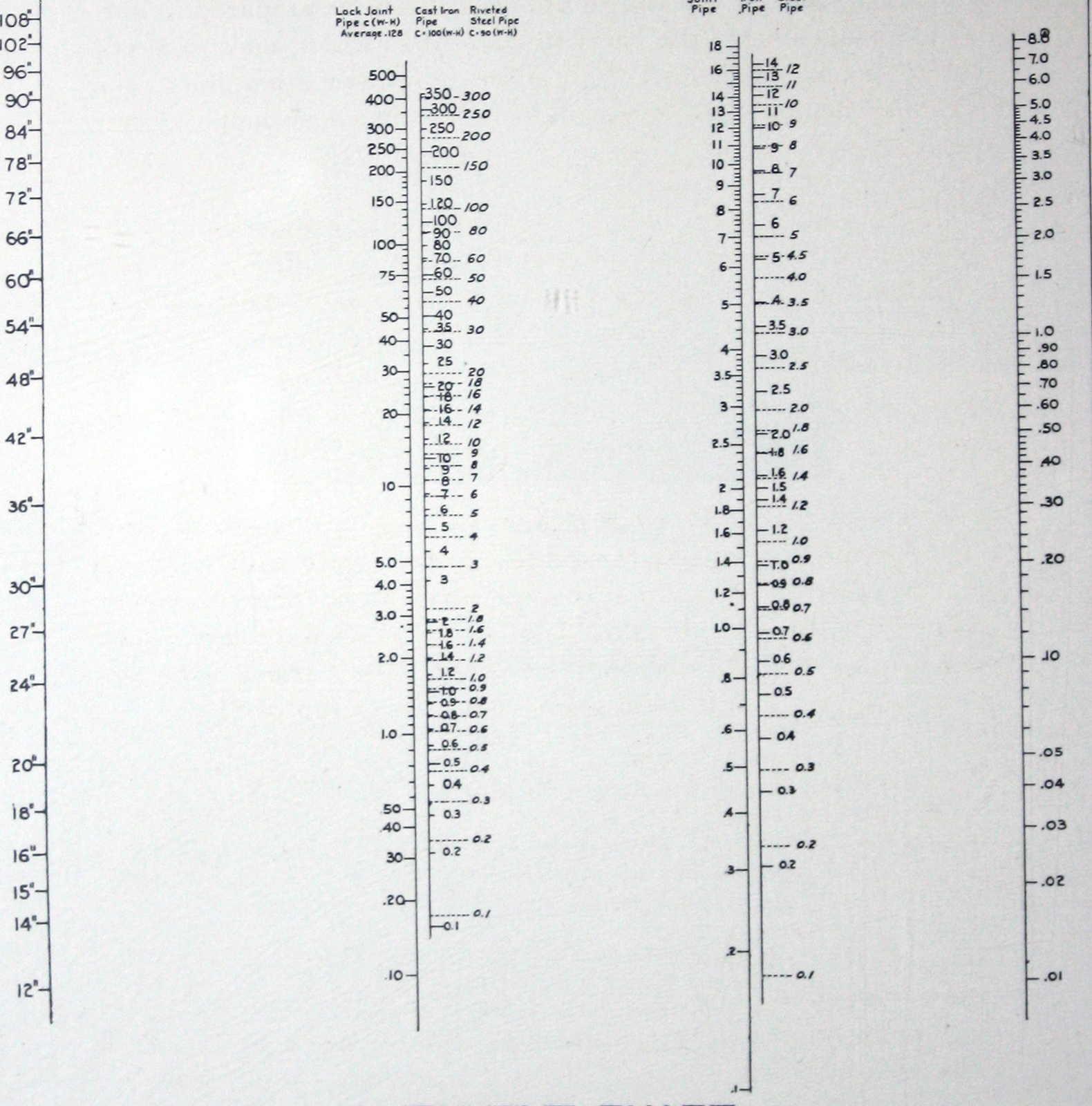
VELOCITY	1 Ft. per Sec.		3' per Sec.		5' per Sec.		10' per Sec.	
DIAMETER	"C"	"N"	"C"	"N"	"C"	"N"	"C"	"N"
12"	135	.0106	124	.0110	118	.0110	112	.0111
24"	137	.0107	127	.0115	124	.0115	116	.0117
48"	141	.0114	130	.0119	125	.0120	119	.0120
96"	150	.0115	136	.0120	130	.0121	123	.0123

SCOBEY'S FORMULA-$Q = 0.00546\ C_S d^{2.625} H^{0.5}$

Q = Discharge in Cubic Feet per Second = Sec. Ft.
H = Loss of Head from Friction in Feet per 1000 Feet.
d = Internal Diameter of Pipe in inches.
C_S = Scobey's Coefficient - Value Adopted = 0.360

FOR CAST IRON PIPE
Williams-Hazen Formula
C = 100 for pipe 20 years old.

FOR RIVETED STEEL PIPE
Williams-Hazen Formula
C = 90 for pipe 20 years old.

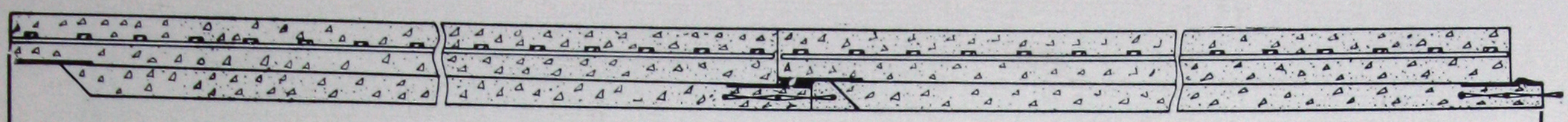


ALIGNMENT CHART

OF

DISCHARGE AT THE END OF 20 YEARS FOR "LOCK JOINT" REINFORCED CONCRETE PIPE, CAST IRON PIPE AND RIVETED STEEL PIPE, COMPUTED BY FORMULA AS SHOWN ABOVE

A STRAIGHT LINE DRAWN ACROSS THE SIX SCALES, INTERSECTS AT CORRESPONDING VALUES OF DIAMETER, DISCHARGE, VELOCITY AND LOSS OF HEAD



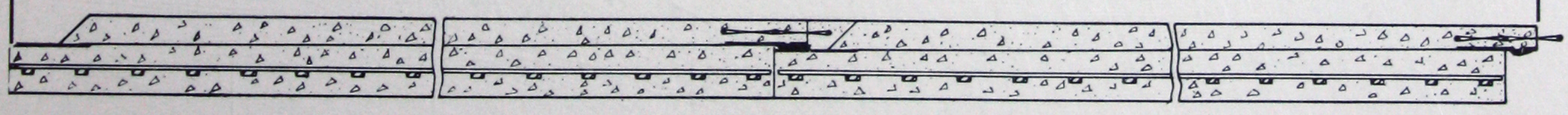
Alignment Chart

THE alignment chart shown opposite has been prepared to indicate conveniently the carrying capacities which may conservatively be expected in Lock Joint Pipe Lines and other lines after they have been in use for some time. The co-efficients used in constructing this chart were selected as follows:

The best available information as to carrying capacities of reinforced concrete pipe lines is that compiled by Mr. Fred C. Scobey, in Bulletin 852, U. S. Department of Agriculture. As a result of his studies he gives a value of $C_s = 0.370$ in his formula as applying to "jointed lines of units made from wet, well spaded concrete, deposited against oiled steel forms, and allowed to set firmly before forms are stripped." Lock Joint Pressure Pipe Lines conform to the highest interpretation of this description. While actual measured results in Lock Joint Lines show better than this, a co-efficient slightly lower, that is, less favorable, has been used with a view to fair conservativeness in the construction of the chart; namely, $C_s = 0.360$. The corresponding values of "*C*" in Williams-Hazen's formula, and "*n*" in the Kutter formula, for various values of velocity and diameter are given in the table at top of chart.

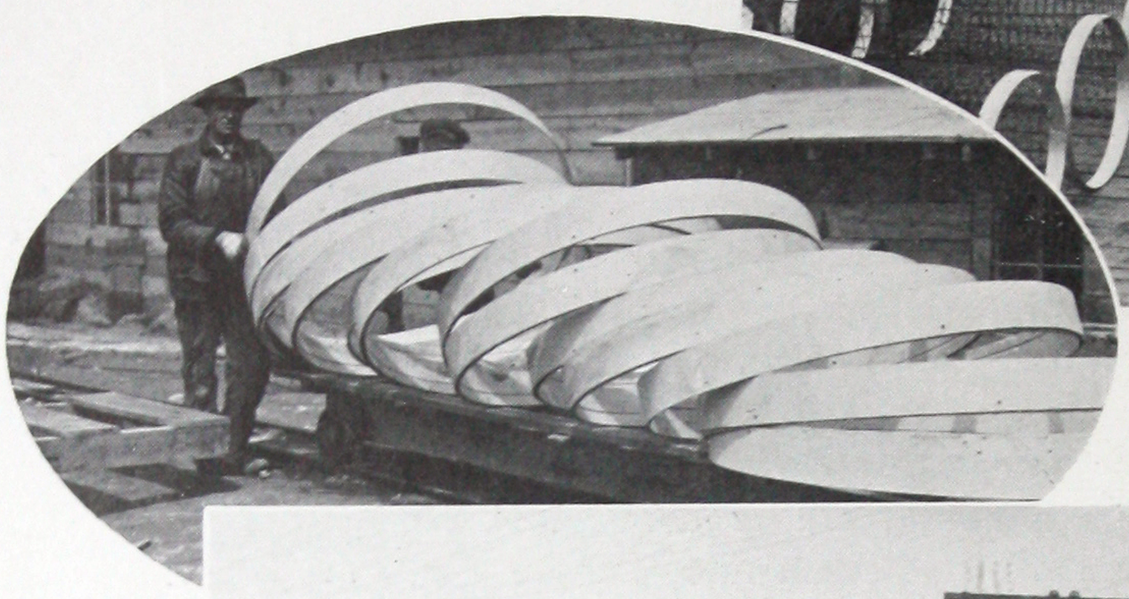
For cast iron and riveted steel pipe lines, the values of "*C*" used are the average values indicated in the Williams-Hazen tables as applying after about 20 years of contact with moderately aggressive waters.

Copies of this alignment chart may be had on request, and also certain other hydraulic diagrams derived from Bulletin 852, U. S. Department of Agriculture, Bureau of Public Roads, by Mr. Fred C. Scobey.



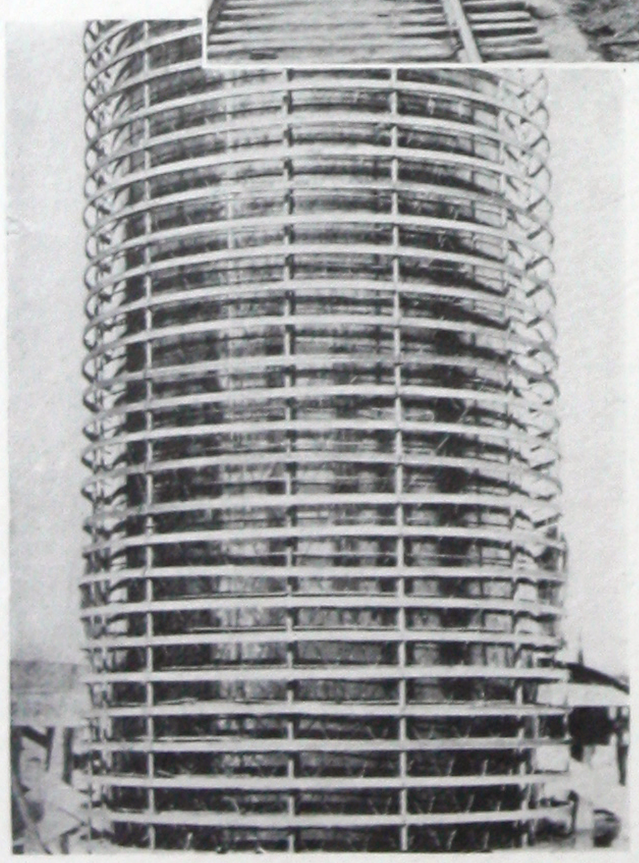


Wire Mesh Cage with Steel Bell and Spigot Rings Attached.



Steel Joint Rings Just from the Galvanizing Shop.



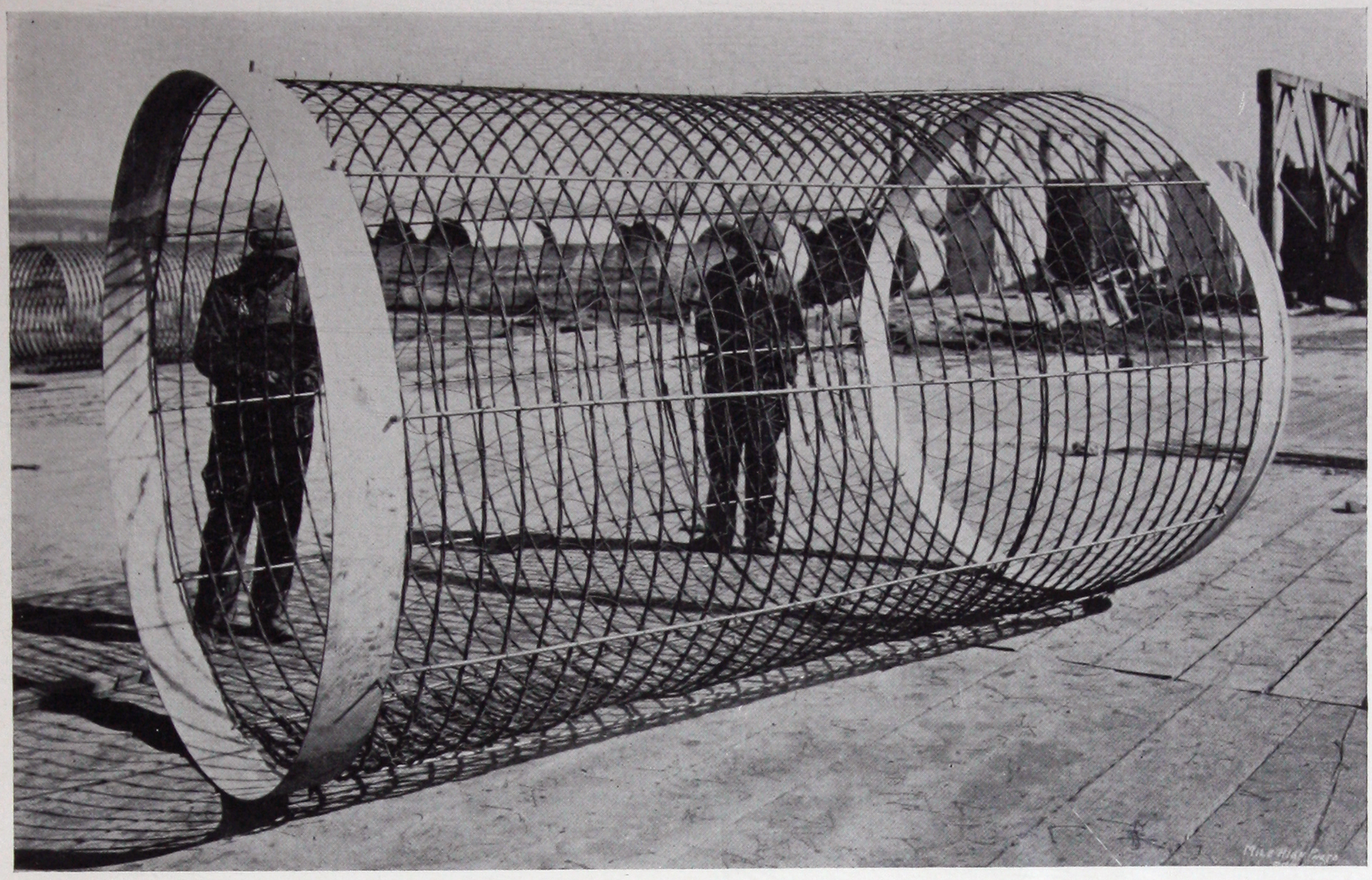


A Corner of the Stock Pile of Steel Bars.

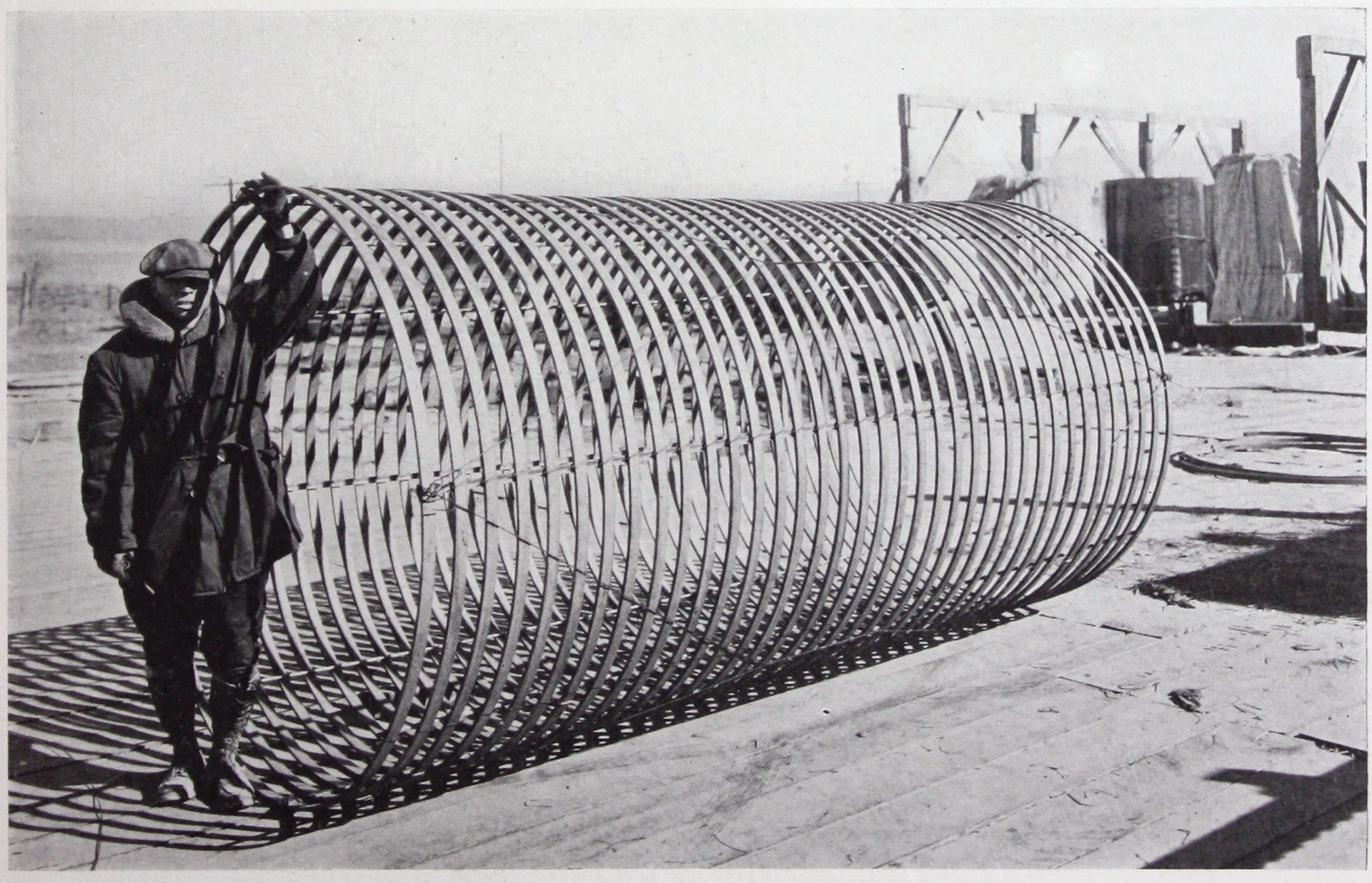


Compression Electric Butt Welder for Making Reinforcement Rings.

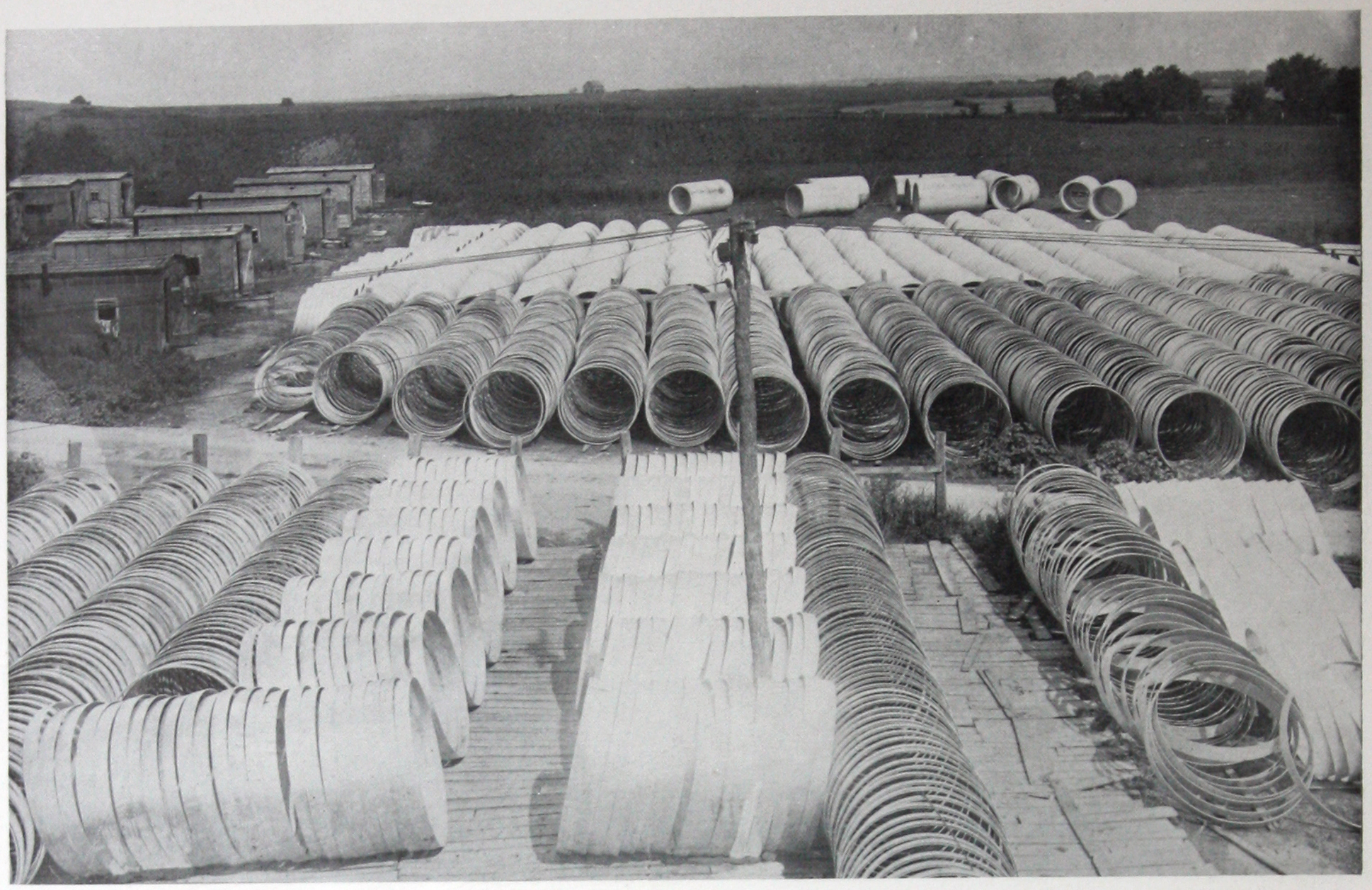
Inner Form with Reinforcement Cages Assembled Thereon.



A Cage of Steel Wire Mesh Showing Longitudinals and Method of Attachment of Bell and Spigot Rings.



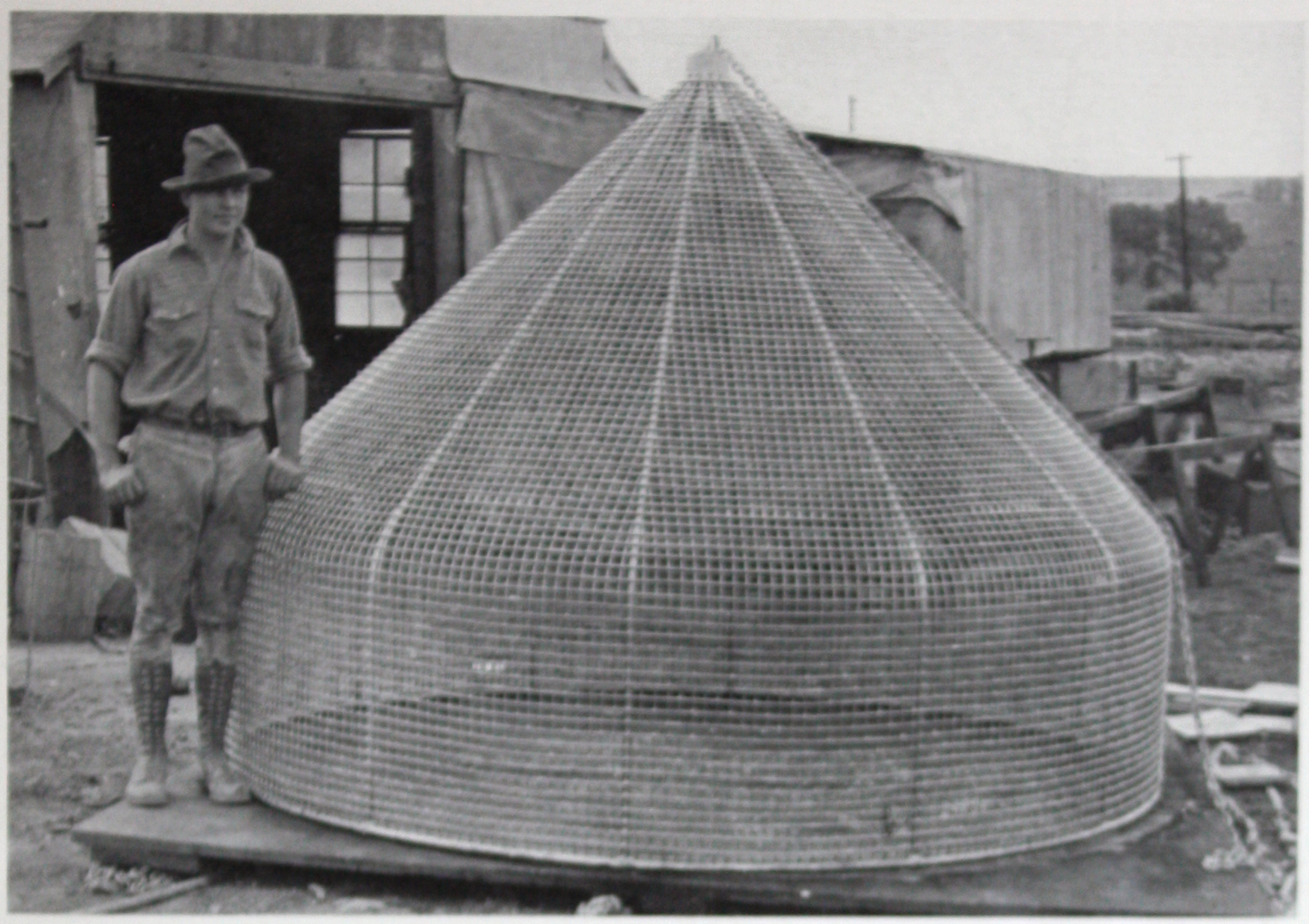
Outside Cage of Welded Steel Rings for 66-inch Pipe.



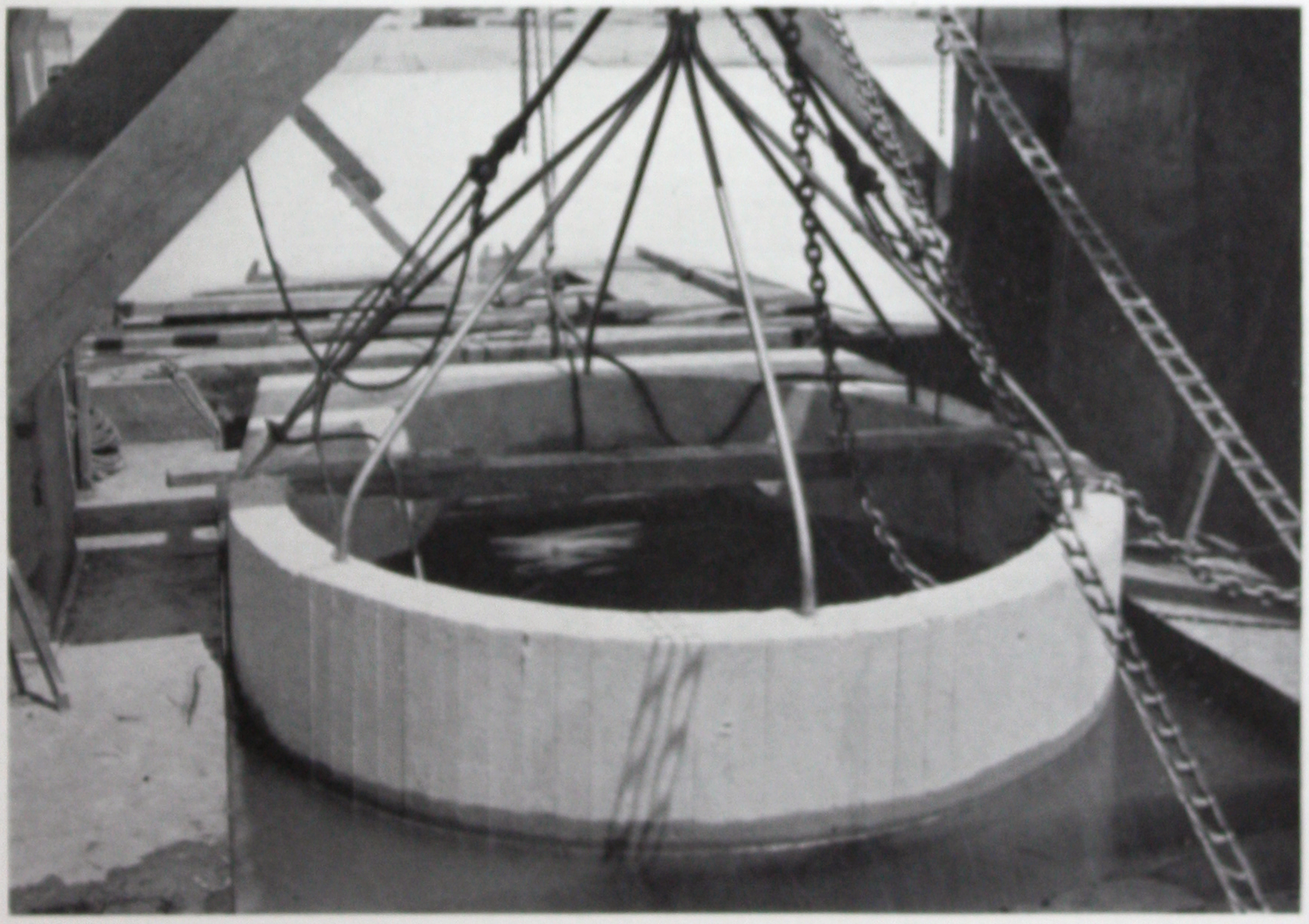
Galvanized Steel Joint Rings in Storage. Manufacturing Yard, Spavinaw Project, Tulsa.



Galvanized Steel Joint Rings in Storage.



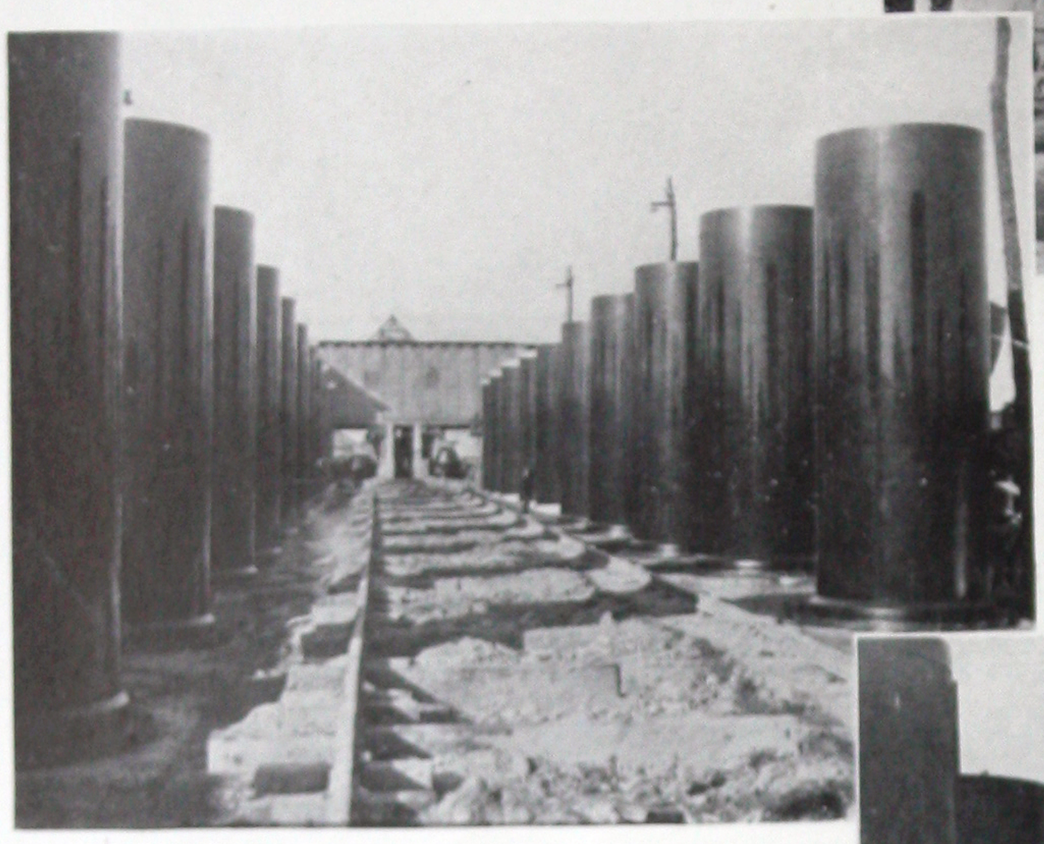
Screen Cage of Bronze Wire for Intake Opening, Marston Lake, Denver.
This Screen Fits over Rods on Top of Concrete Elbow Shown Below.



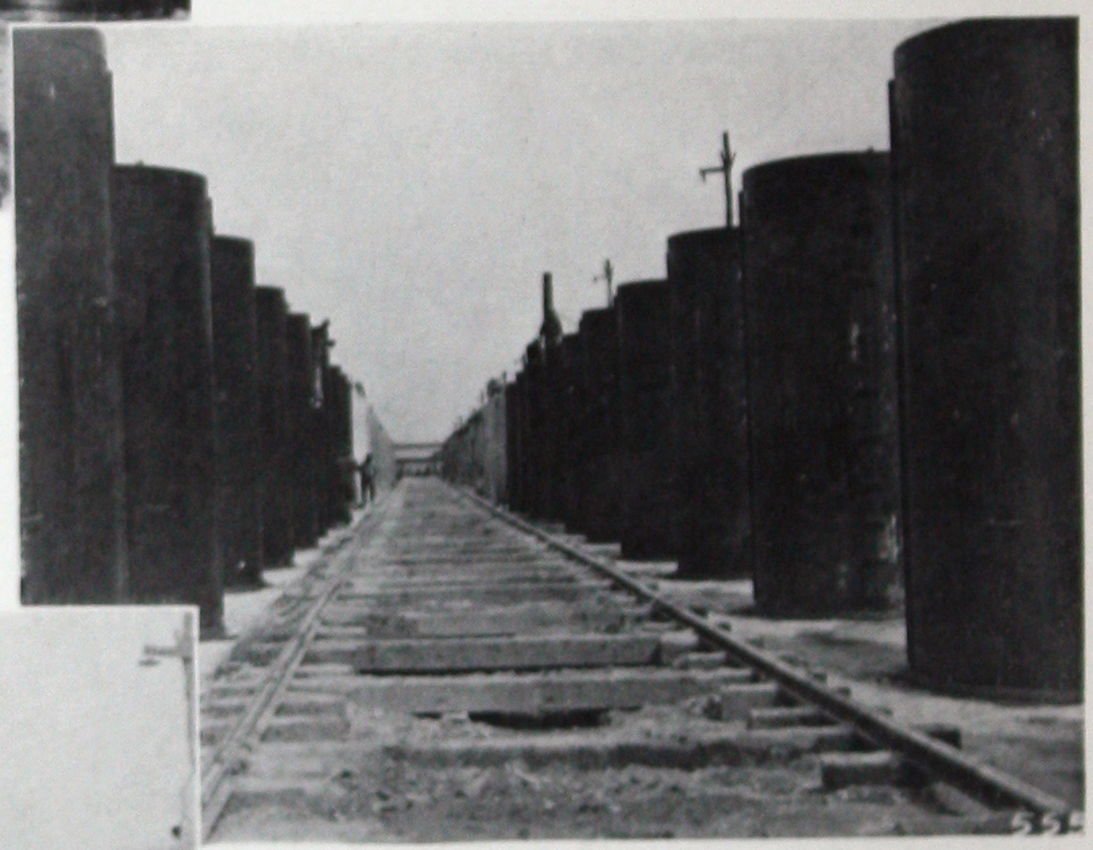
Concrete Elbow at Outer End of 90-inch Subaqueous Pipe, Marston Lake, Denver.



Inner Forms with Mesh Reinforcement Cages and Joint Rings in Place.



Inner Forms in Base Rings.

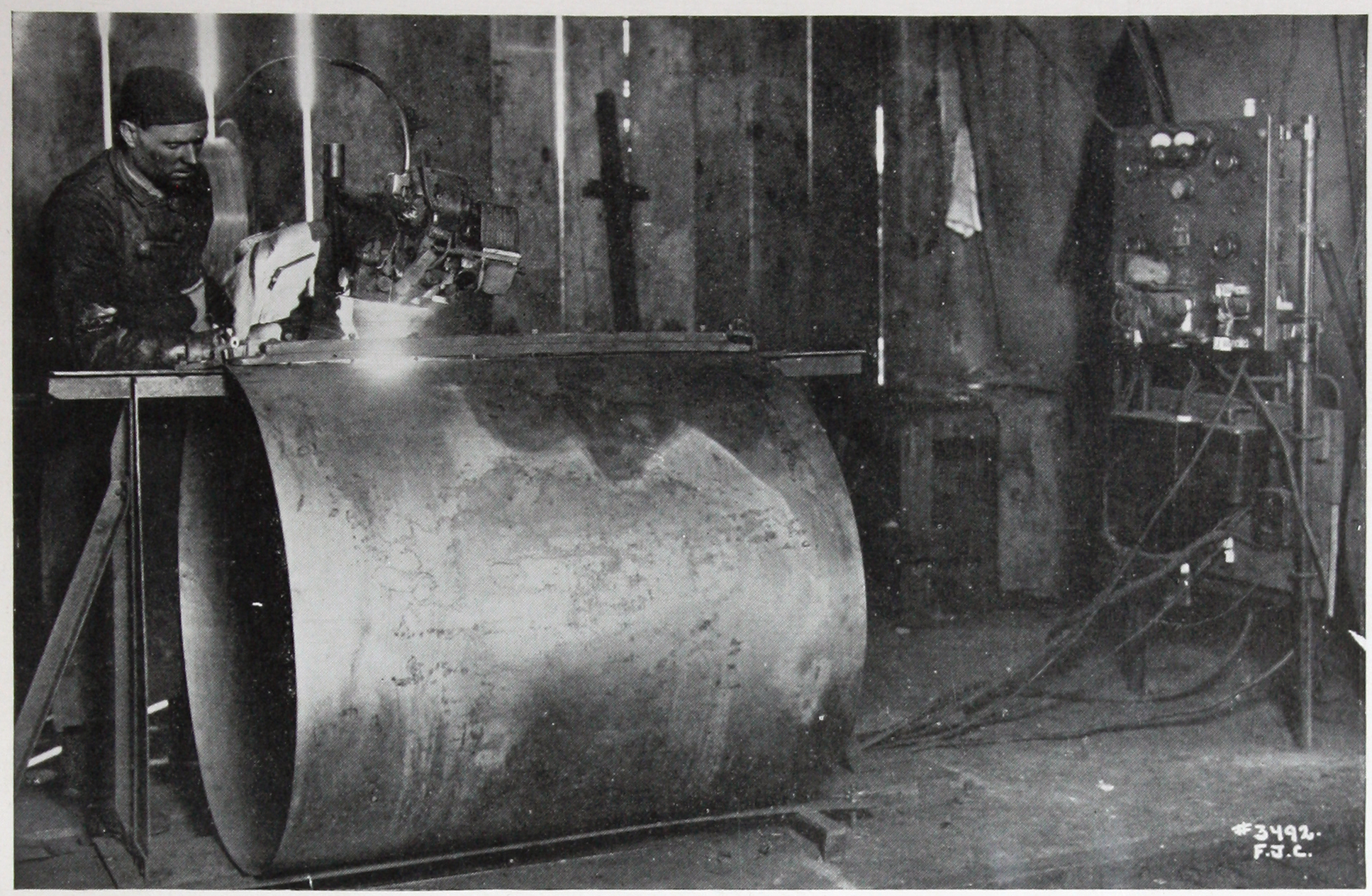


Forms Completely Assembled.

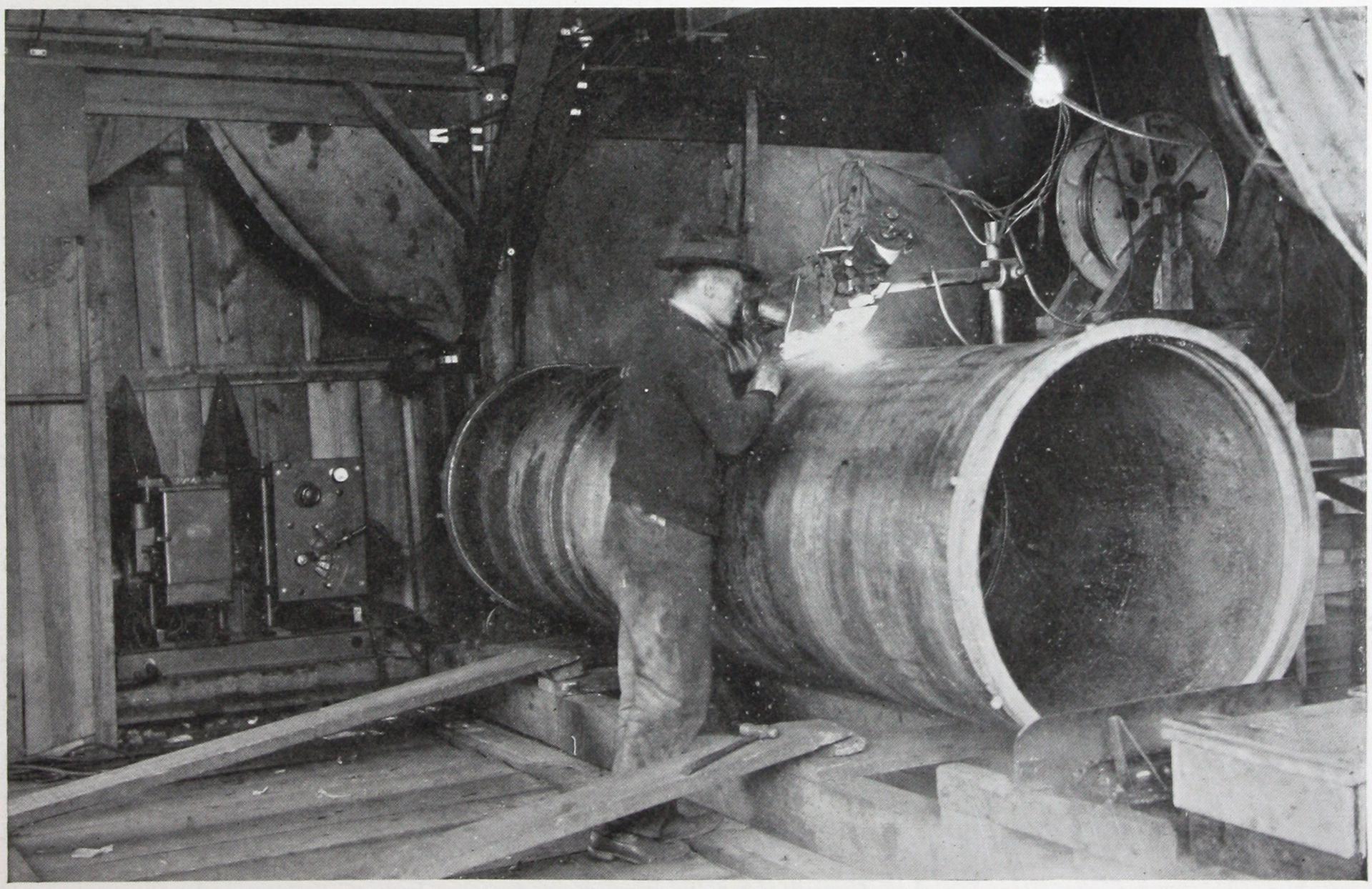


Removing Forms from Finished Pipe.

Various Views of Forms for Poured Pipe.



Welding Longitudinal Seam in Steel Cylinder with Automatic Welder.



Electric Welding of Circumferential Seams.



Finished Cylinders with Joint Rings Attached and Mesh Cage for Inner Lining.

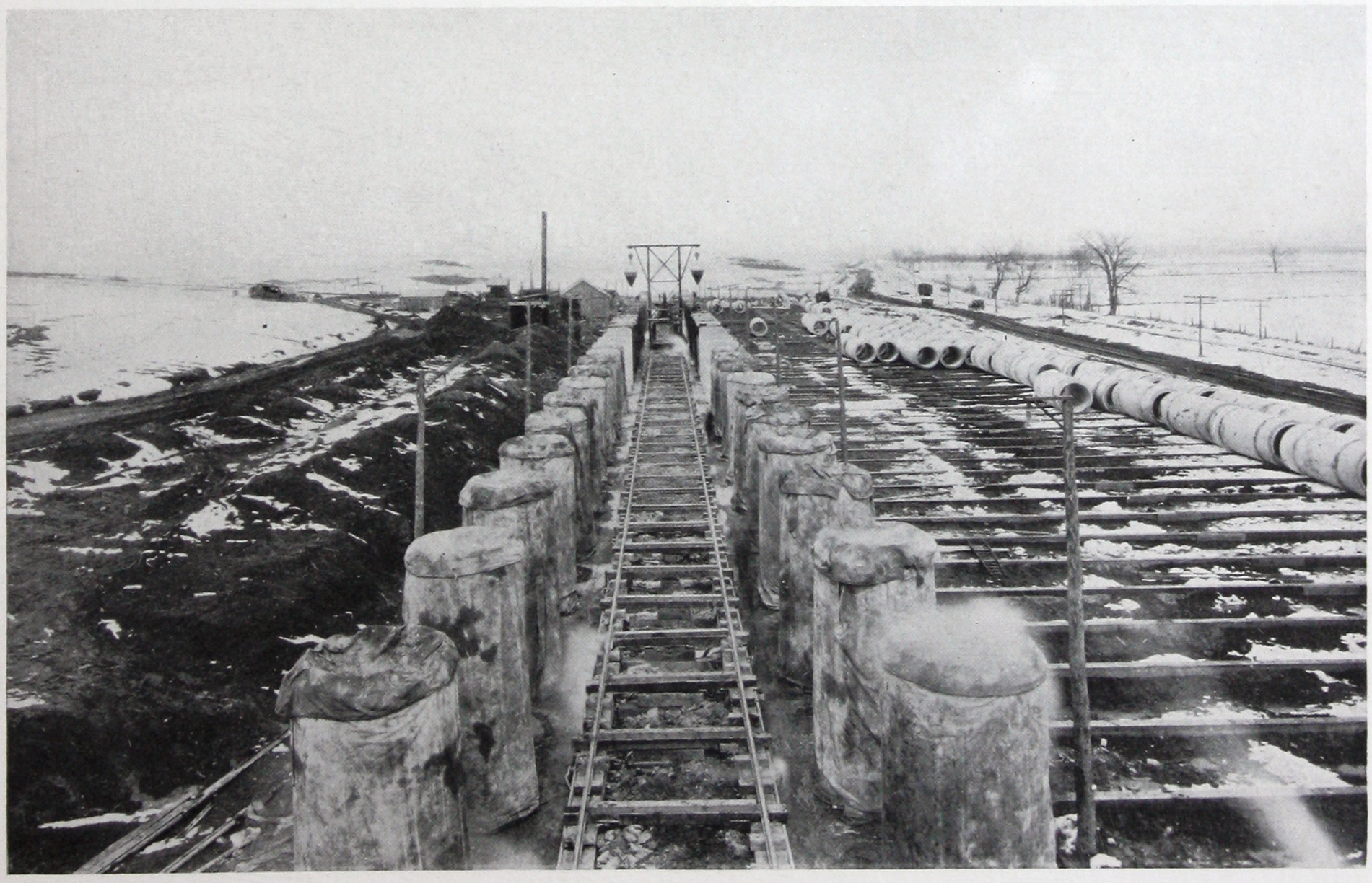


Finished 48-inch Cylinder Pipe, Washington, D.C.

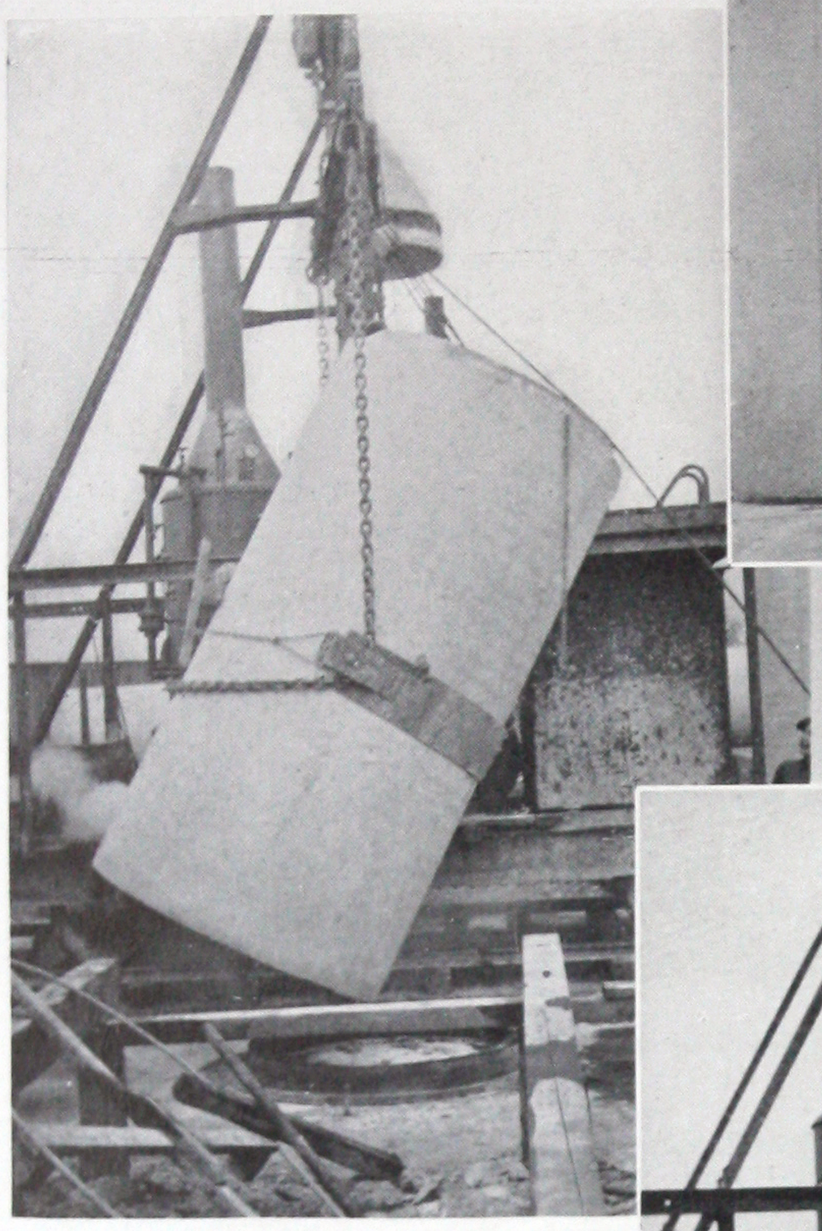
The Cylinders in Picture Above Are Built into This Pipe.



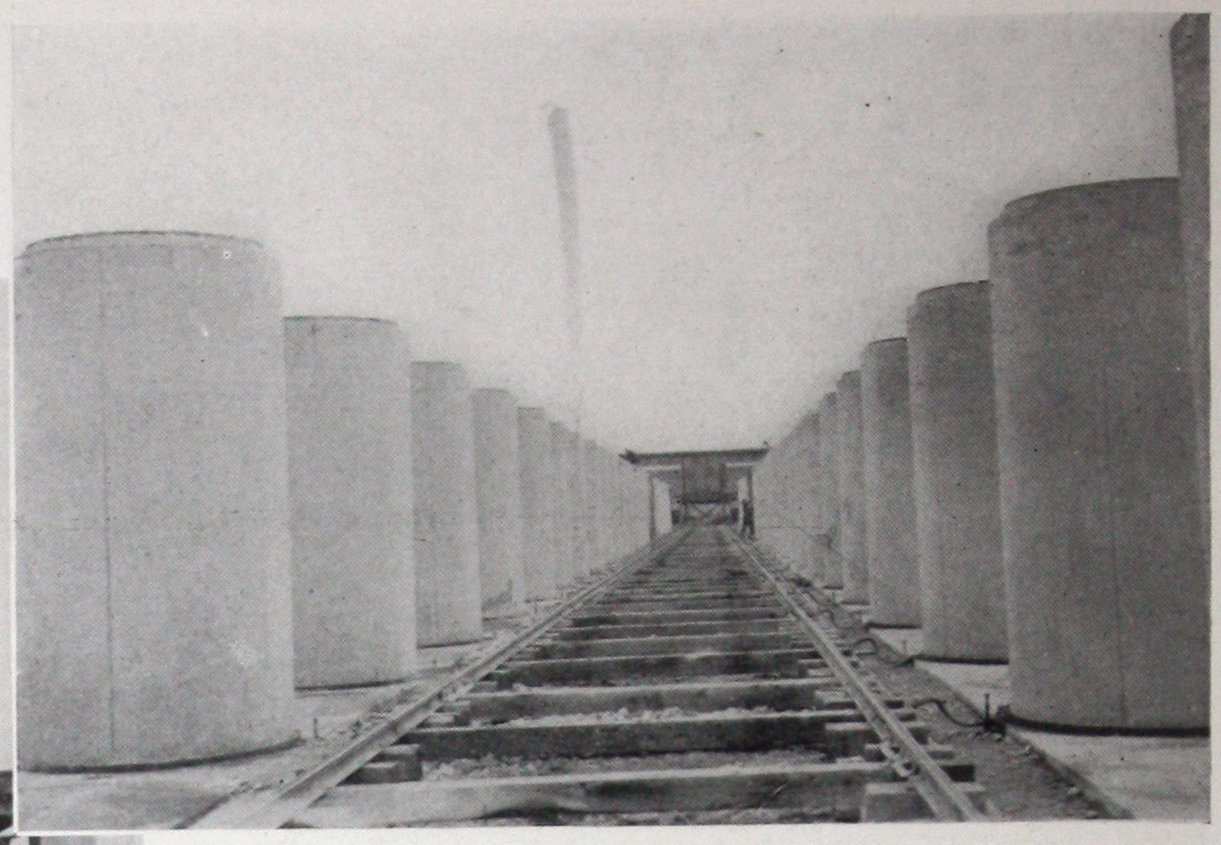
Rows of Newly Finished Pipe with Steam Covers in Place.



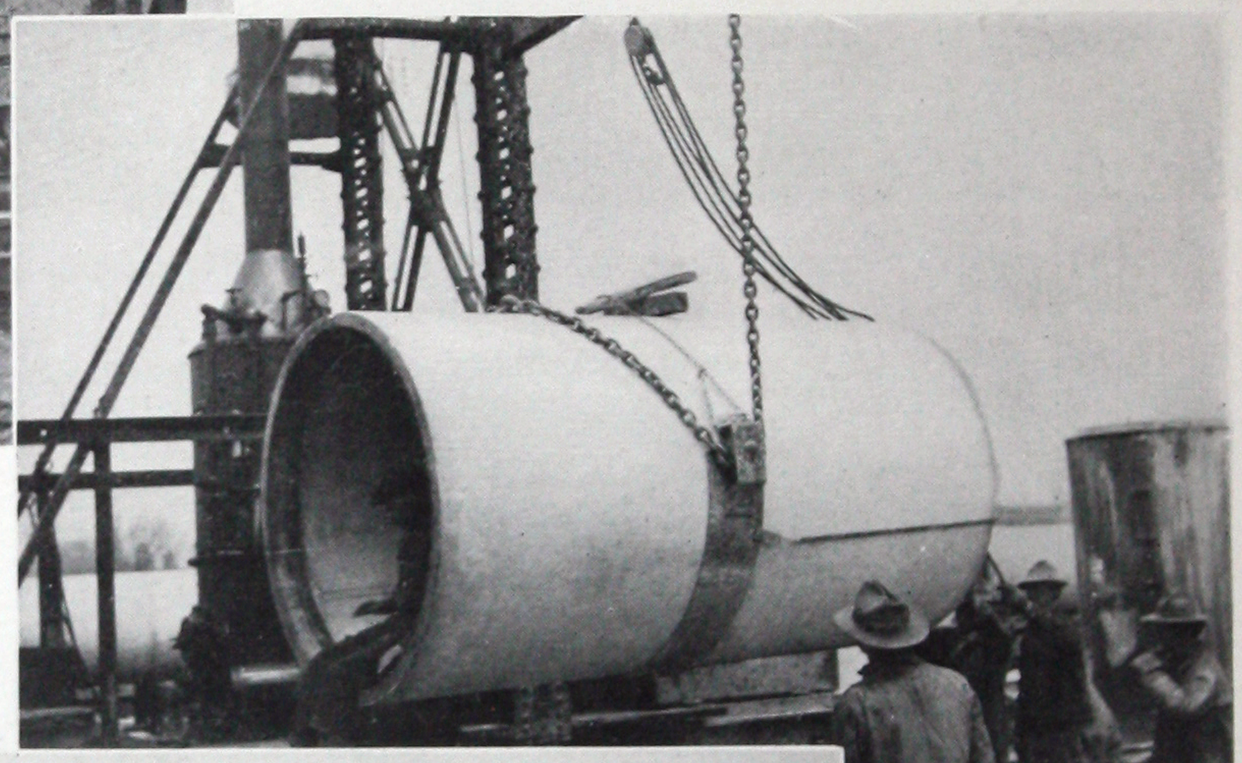
A Winter View of 54-inch Pipe Manufacturing Yard.
Steam Curing Proceeds Even under the Severest Low Temperatures.



Lifting and Turning.



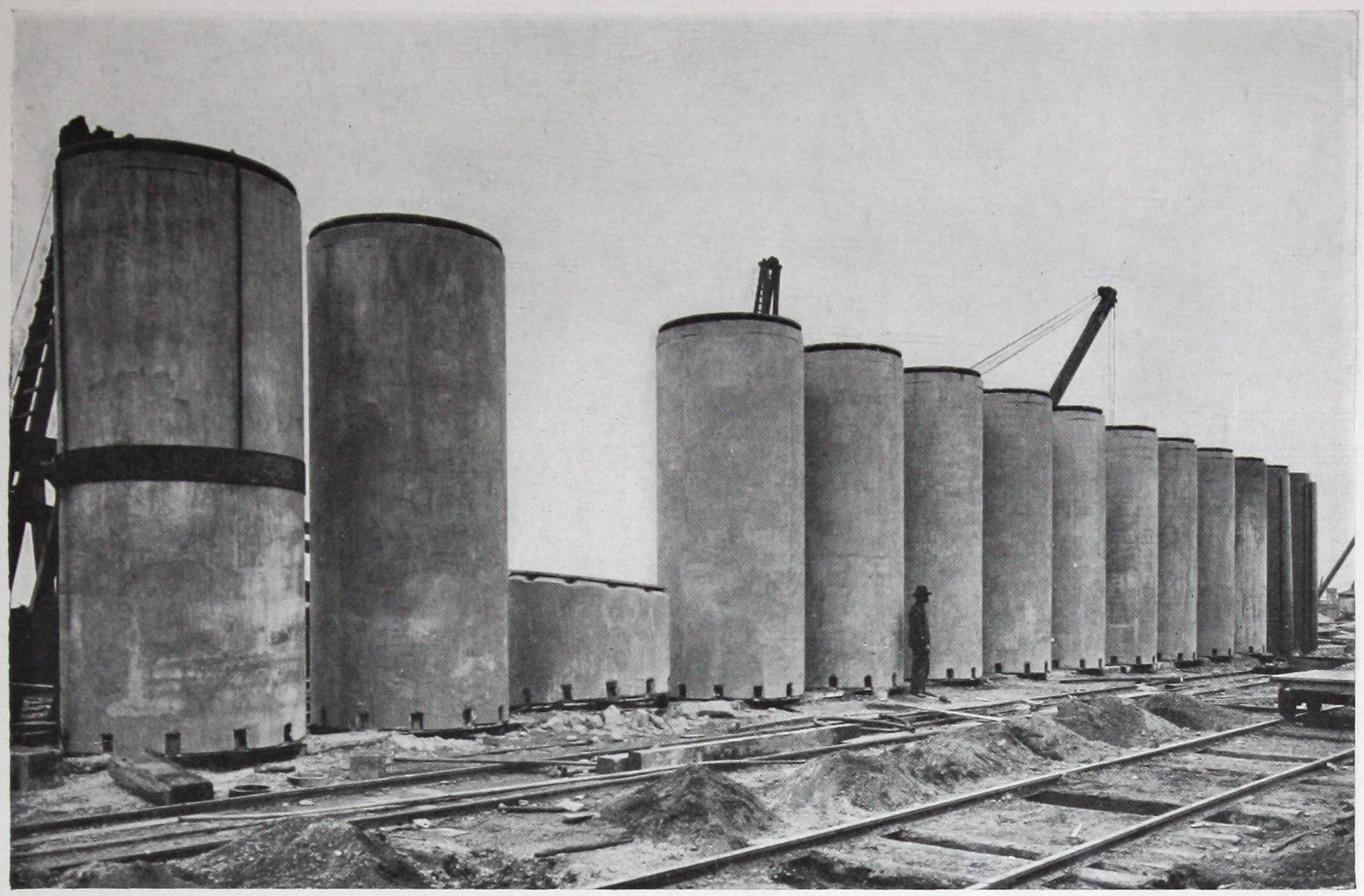
Finished Pipe Ready to Turn.



Turned Ready for Storage.



Delivered along the Line.



72-inch Subaqueous Pipe in 20-foot Lengths, Cleveland, Ohio.



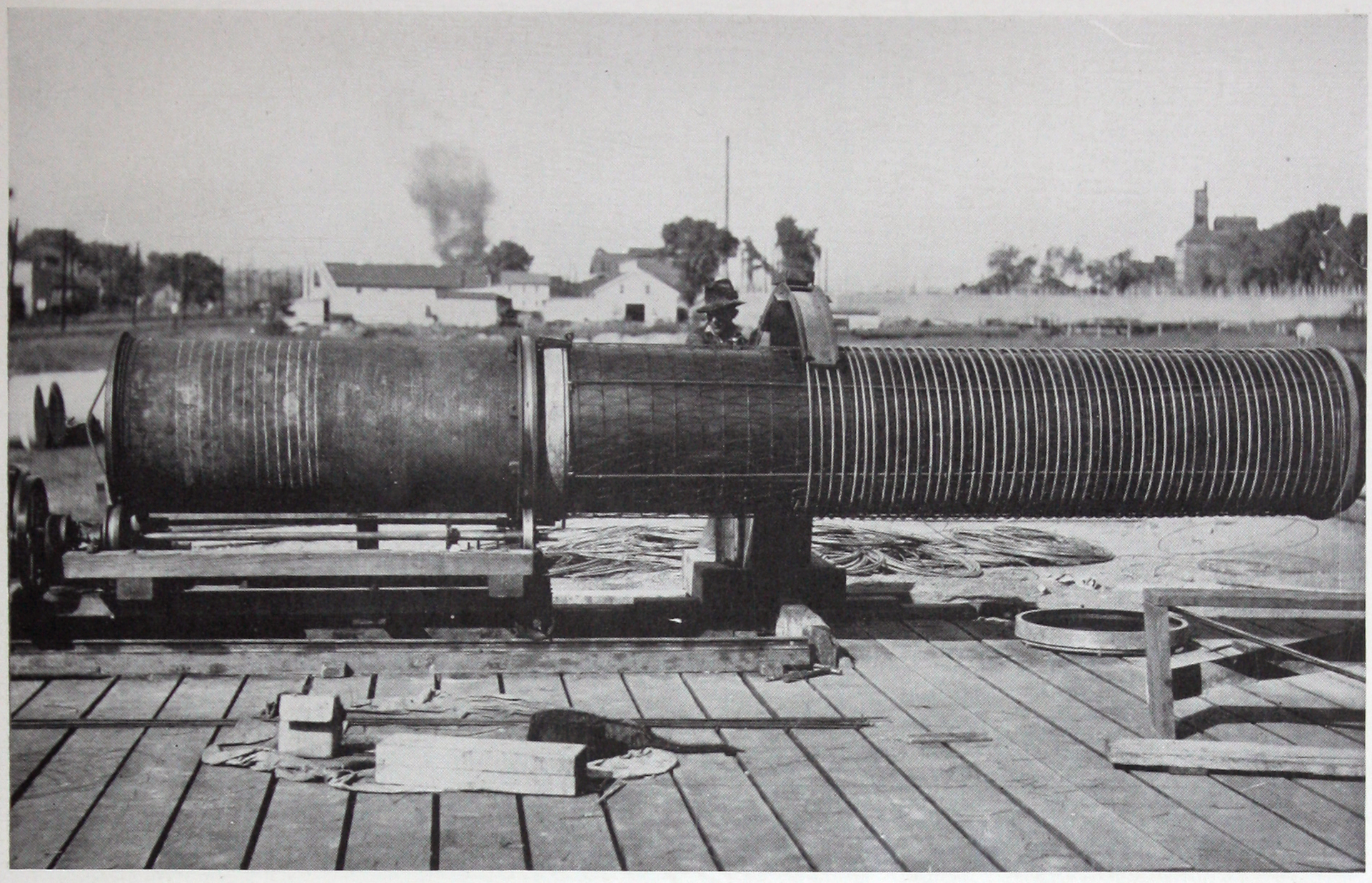
Manufacturing Yard, Baltimore. This Line Is One and One-Half Miles Long Consisting of One Mile of 108-inch and a Half Mile of 84-inch, One Mile of Which Was Laid in an Existing 12-foot Circular Tunnel, Head 80-feet.



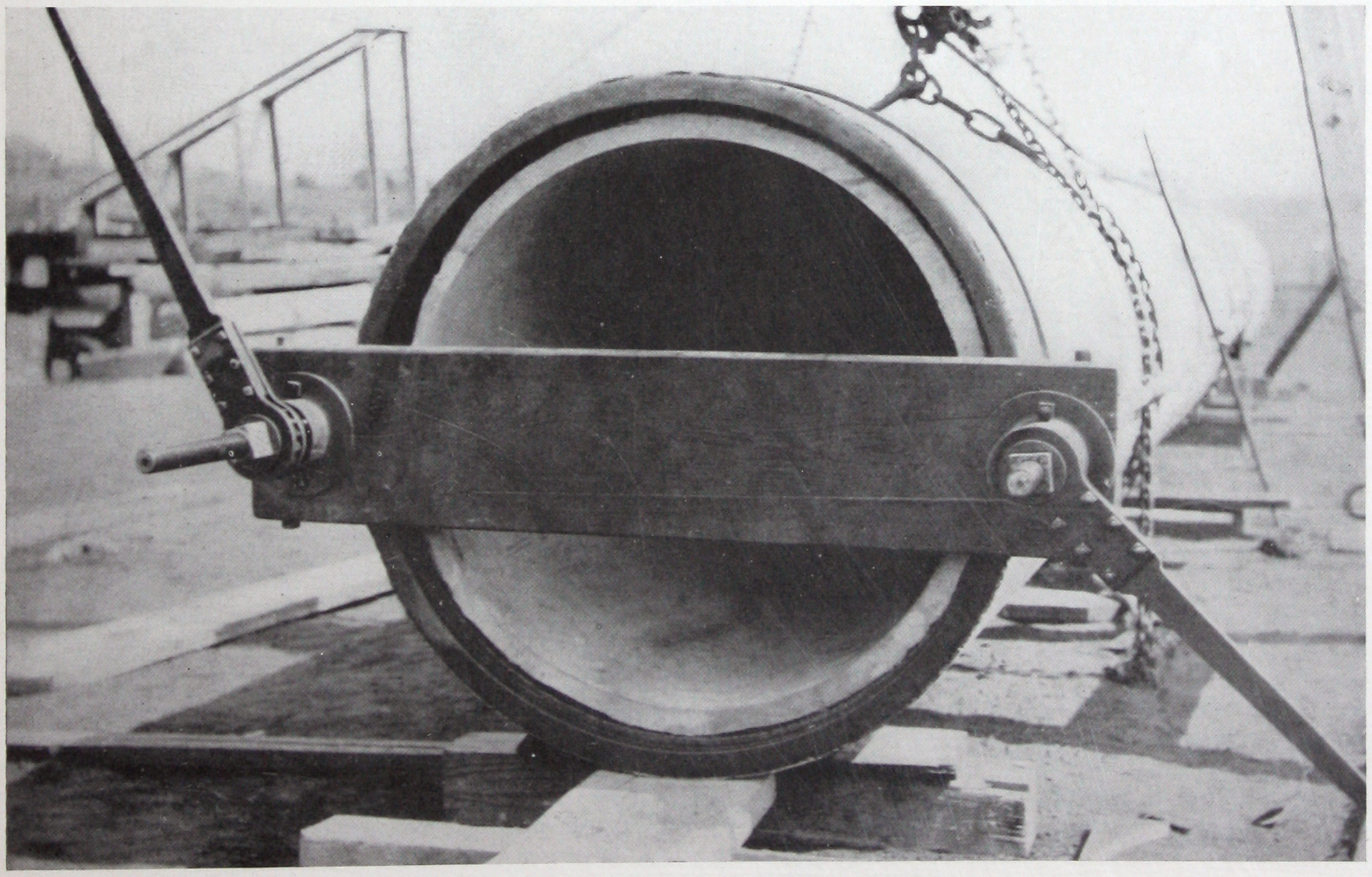
Making Centrifugal Pipe. This Shows Two Steel Moulds for Centrifugal Pipe — the Left-hand One with the Spirally Wound Wire Reinforcement in Place — the Right-hand One with the Concrete Cast and the Trough in Position for Removing Excess Water and Laitance.



30-inch Centrifugal Pipe in Storage Yard, Shreveport, La.



Wire Being Wound Spirally on a Mandrel to Make Reinforcement Cage for Centrifugal Pipe. Joint Rings are Built into the Reinforcement.



Strongback and Ratchet Wrenches for Pulling Self-caulking Lead and Iron Joints Together.



Laying 36-inch Cylinder Pipe with Wheel Derrick.



20-inch Centrifugal Pipe Ready for Laying.

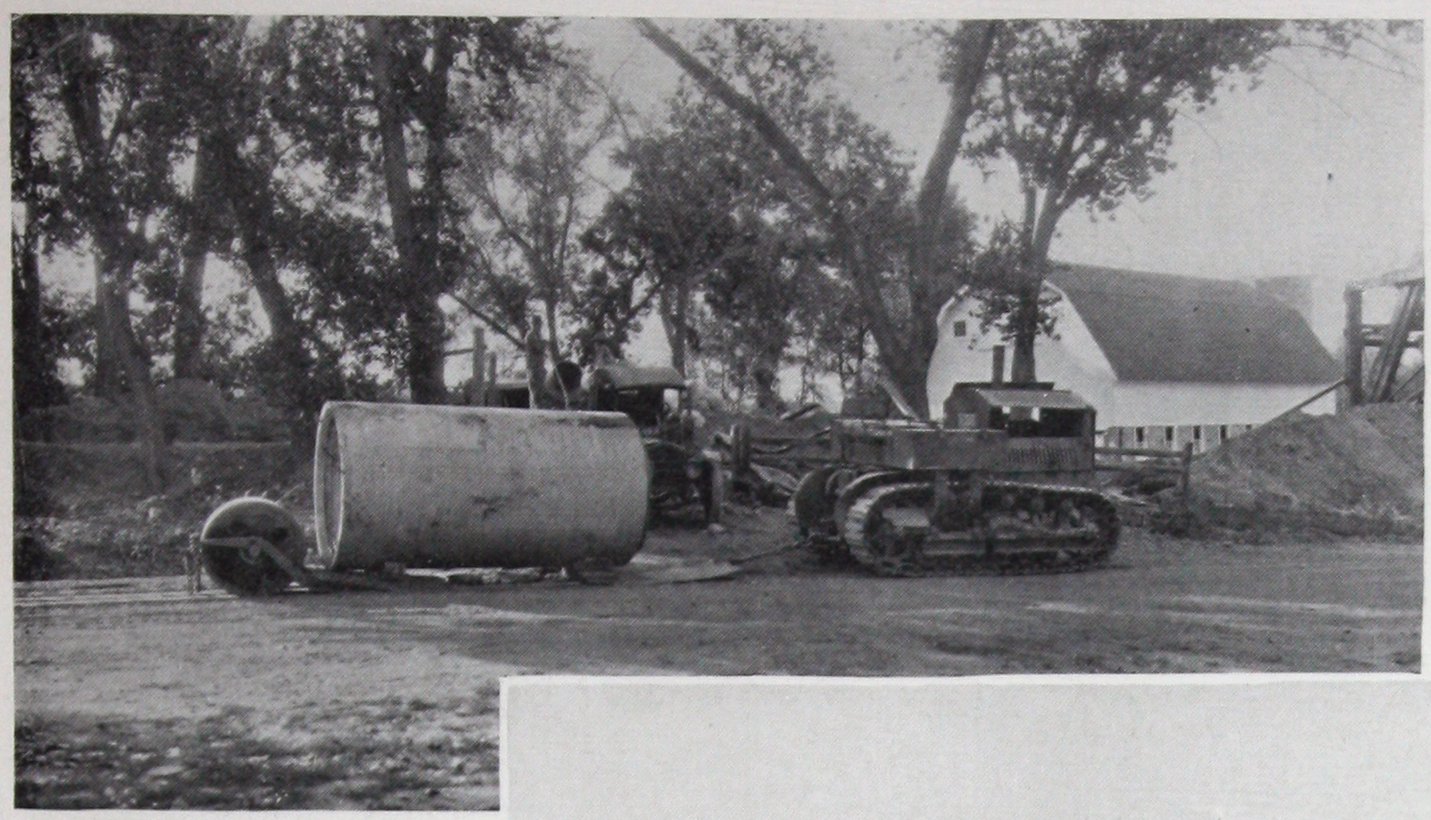


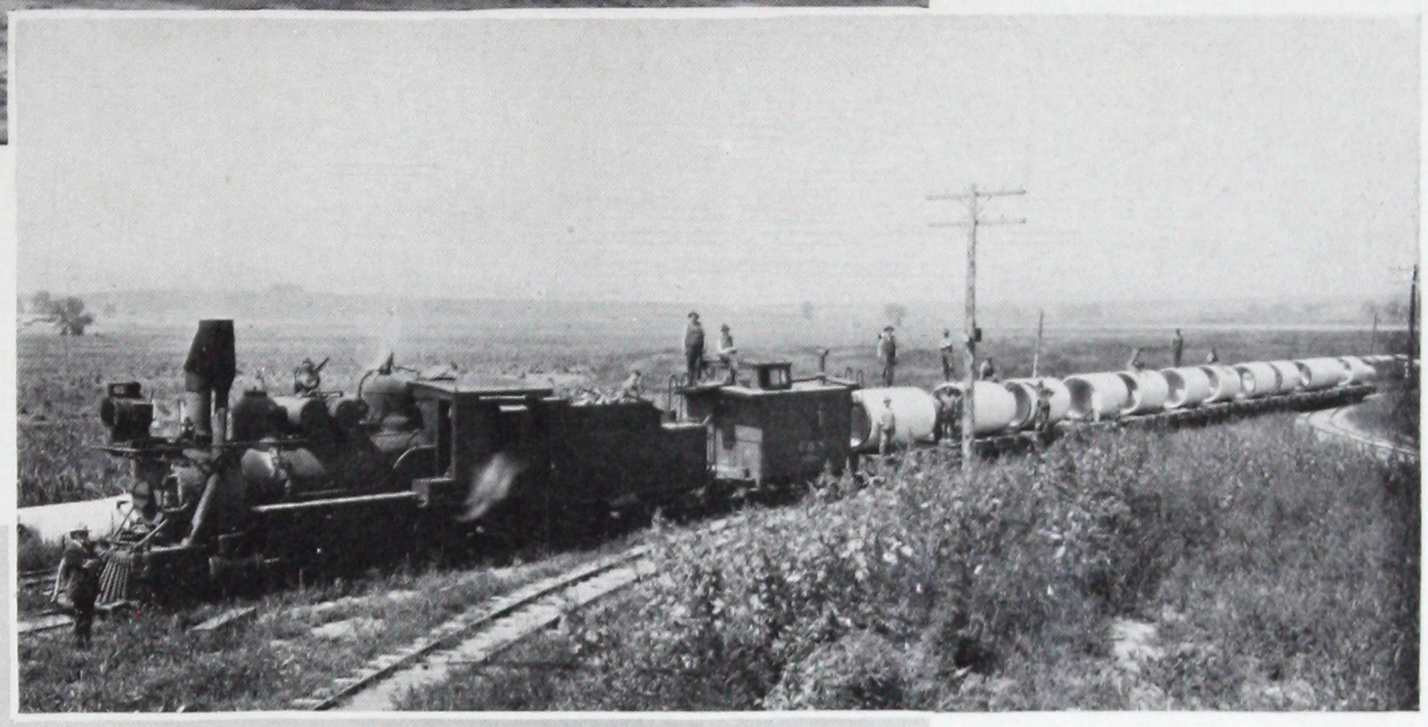


Swinging 27-inch Centrifugal Pipe into Place under Wheel Derrick, Greeley, Colo.
Pulling Up Joint of 27-inch Centrifugal Pipe, Greeley, Colo.



Loading and Unloading Pipe.









Various Methods of Transporting Pipe.

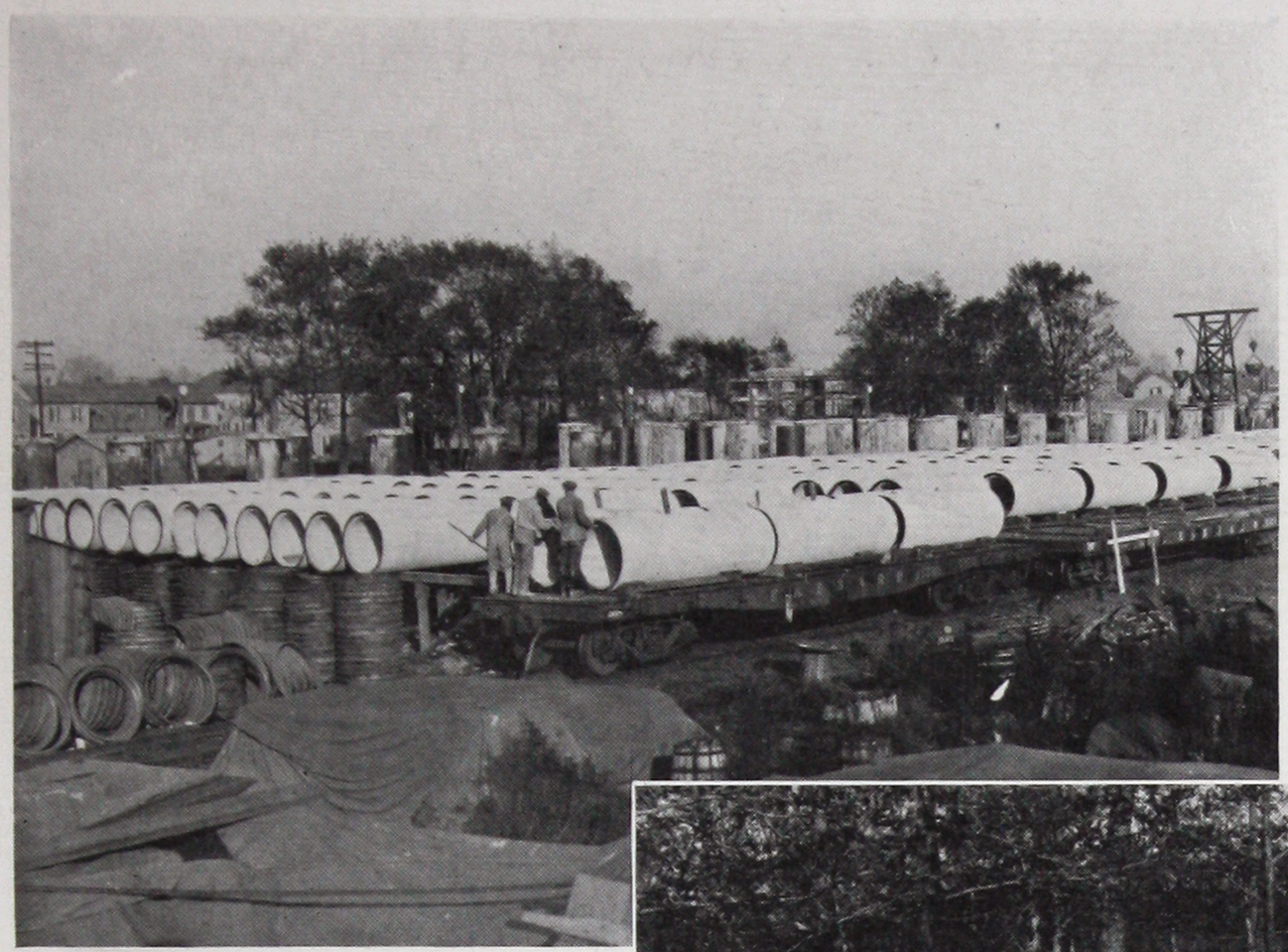








Ditching and Laying under Varied Conditions.



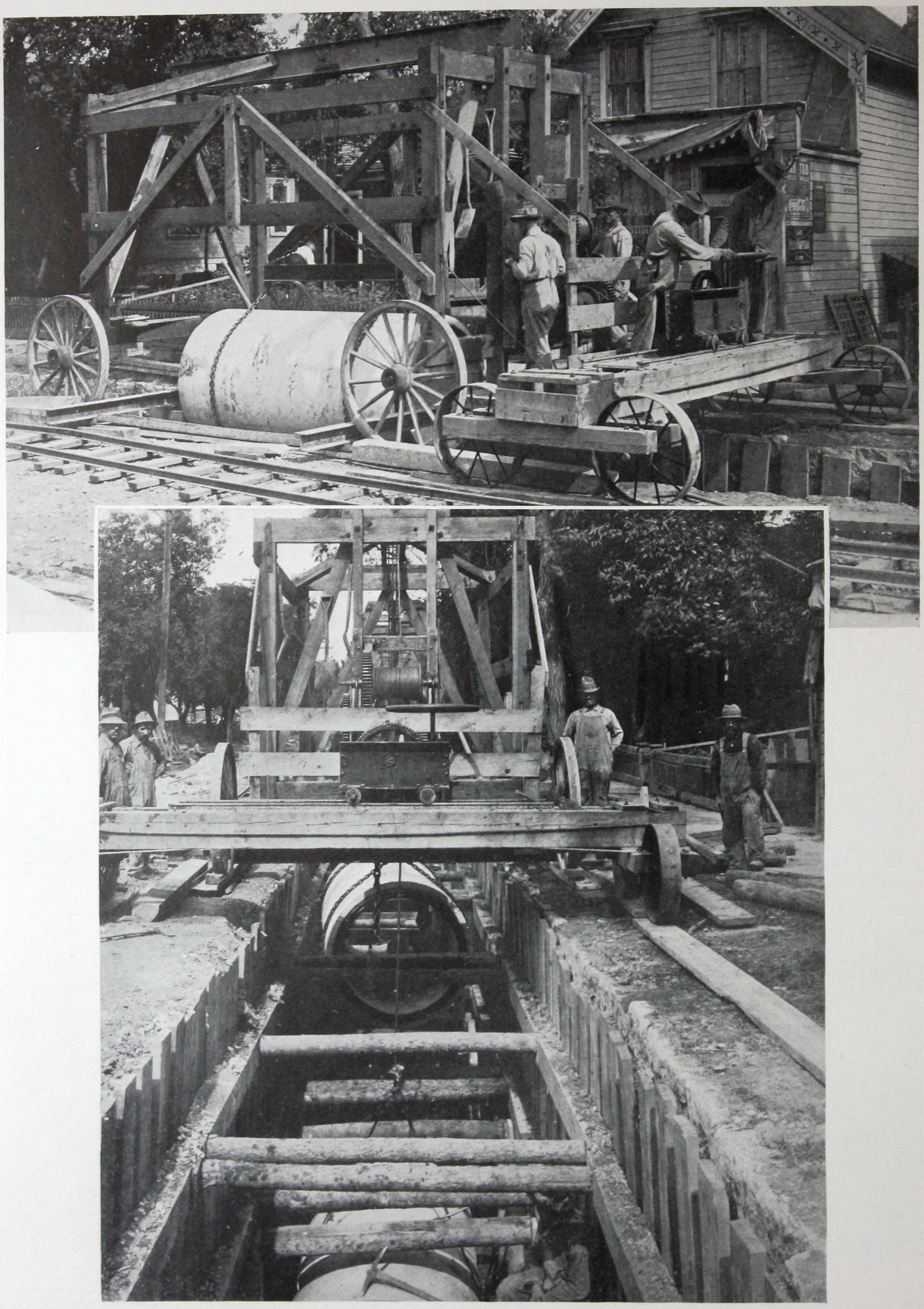
Loading Pipe.



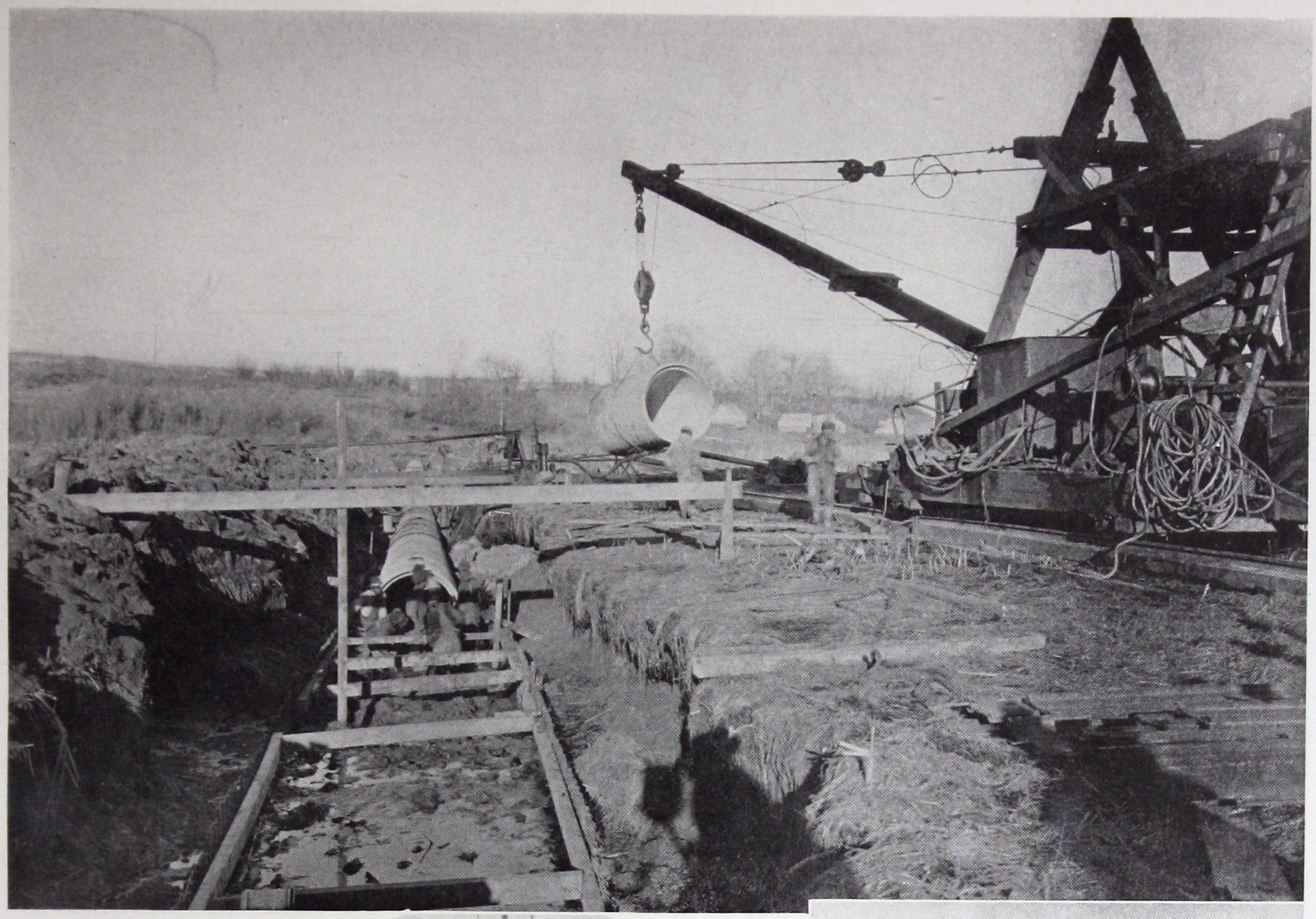
A Sweeping Curve.



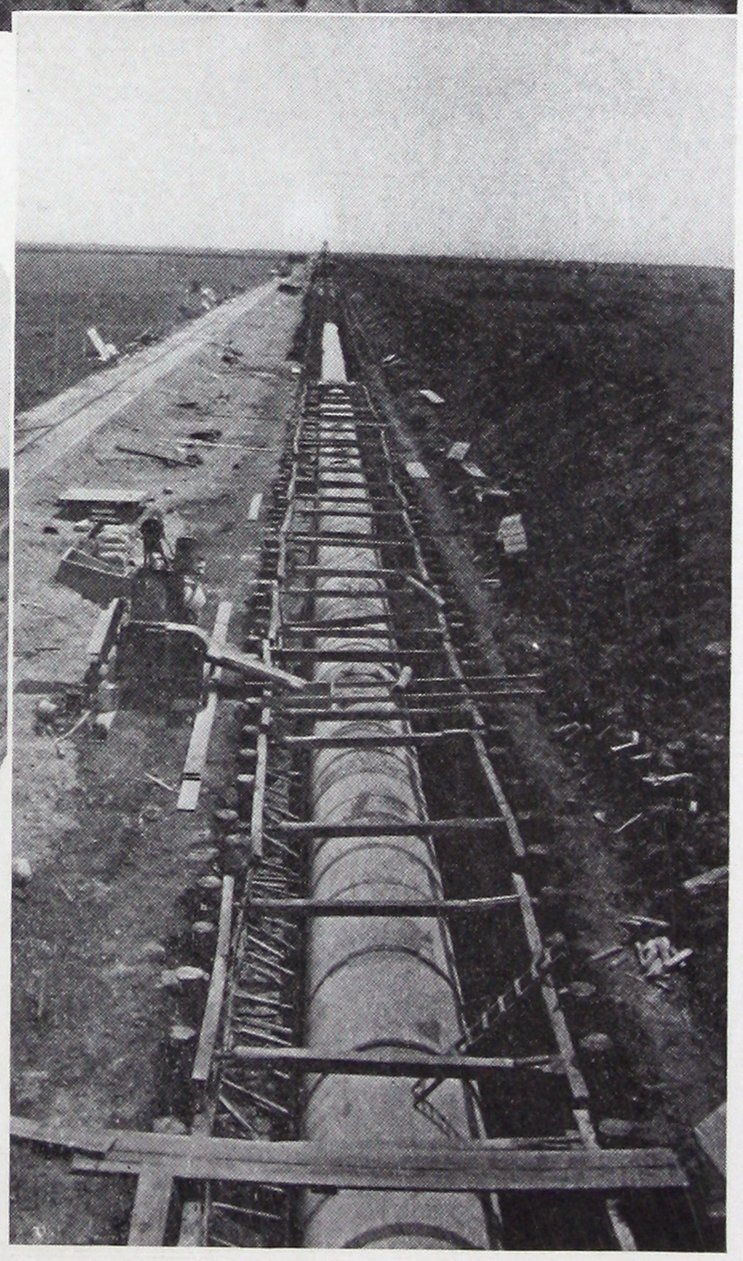
Laying 36-inch Cylinder Pipe.



Laying 48-inch Pressure Pipe Through the Streets.



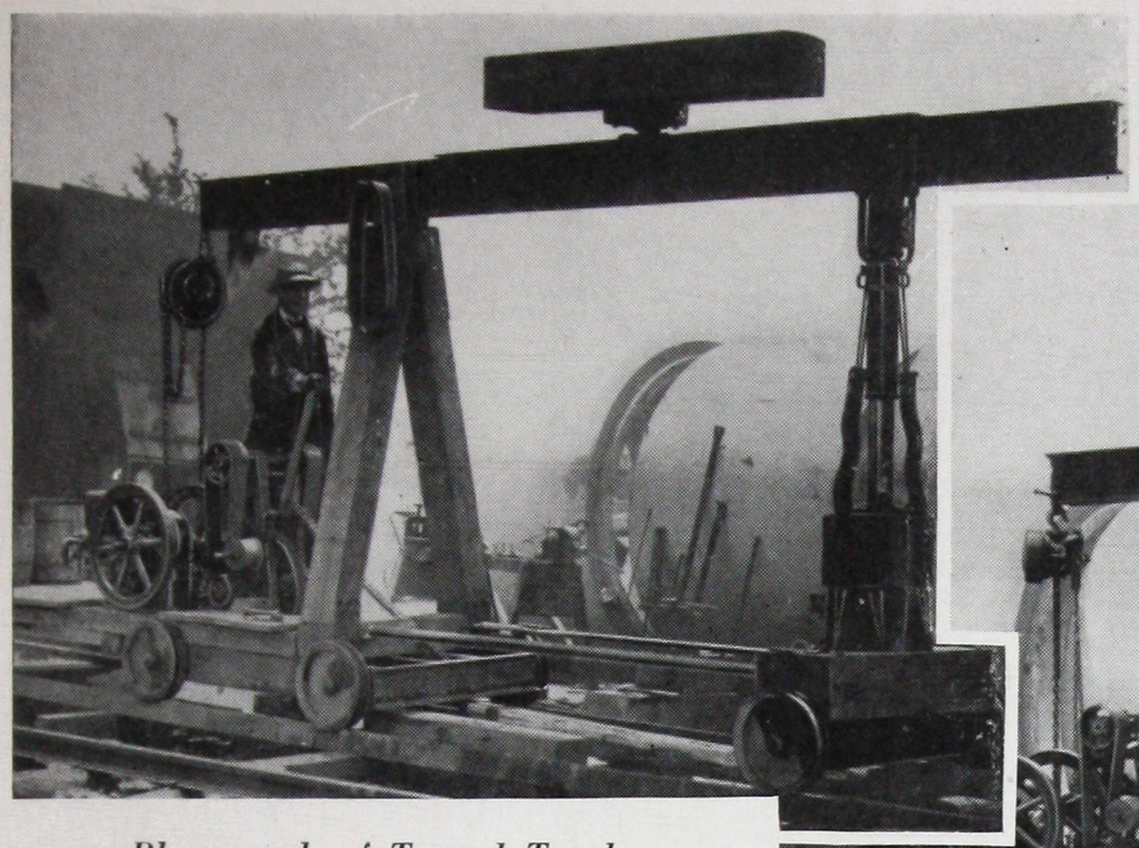




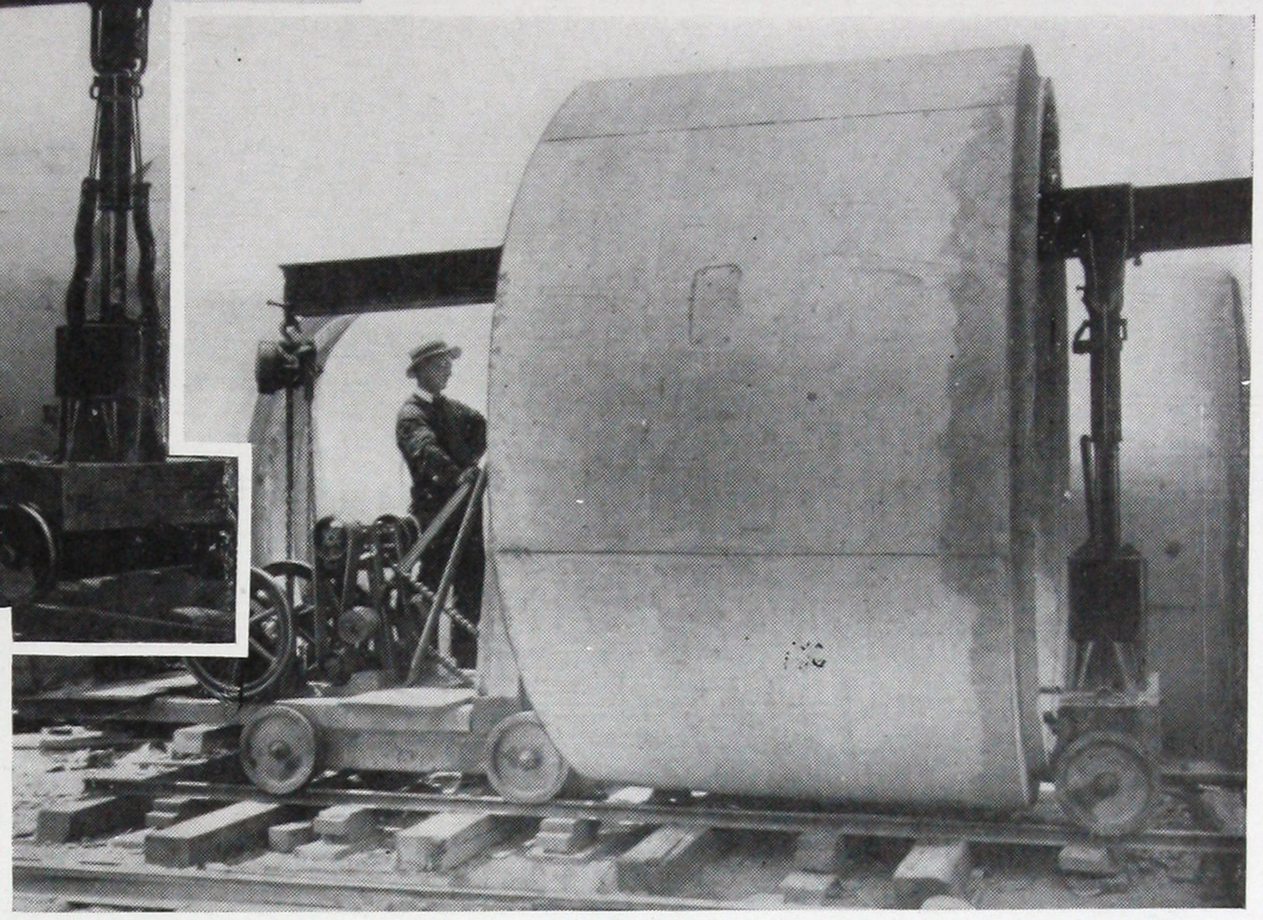
Laying under Troublesome Conditions.



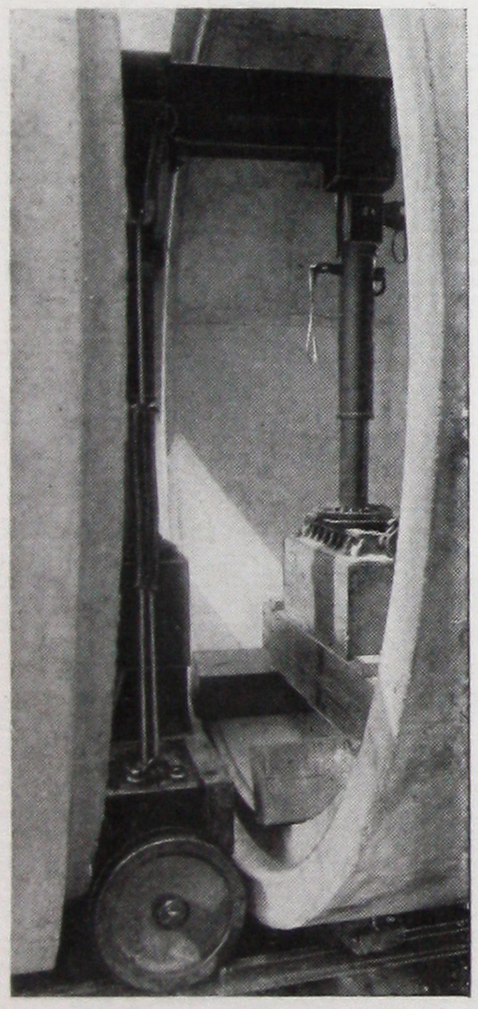
Laying Through Some Difficult Places.



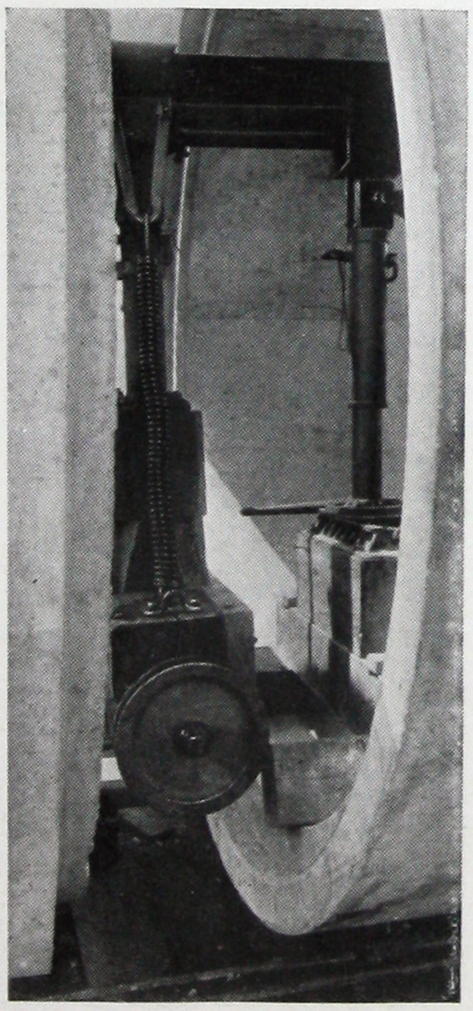
Photograph of Tunnel Truck Operated by a 4 H.P. Engine.



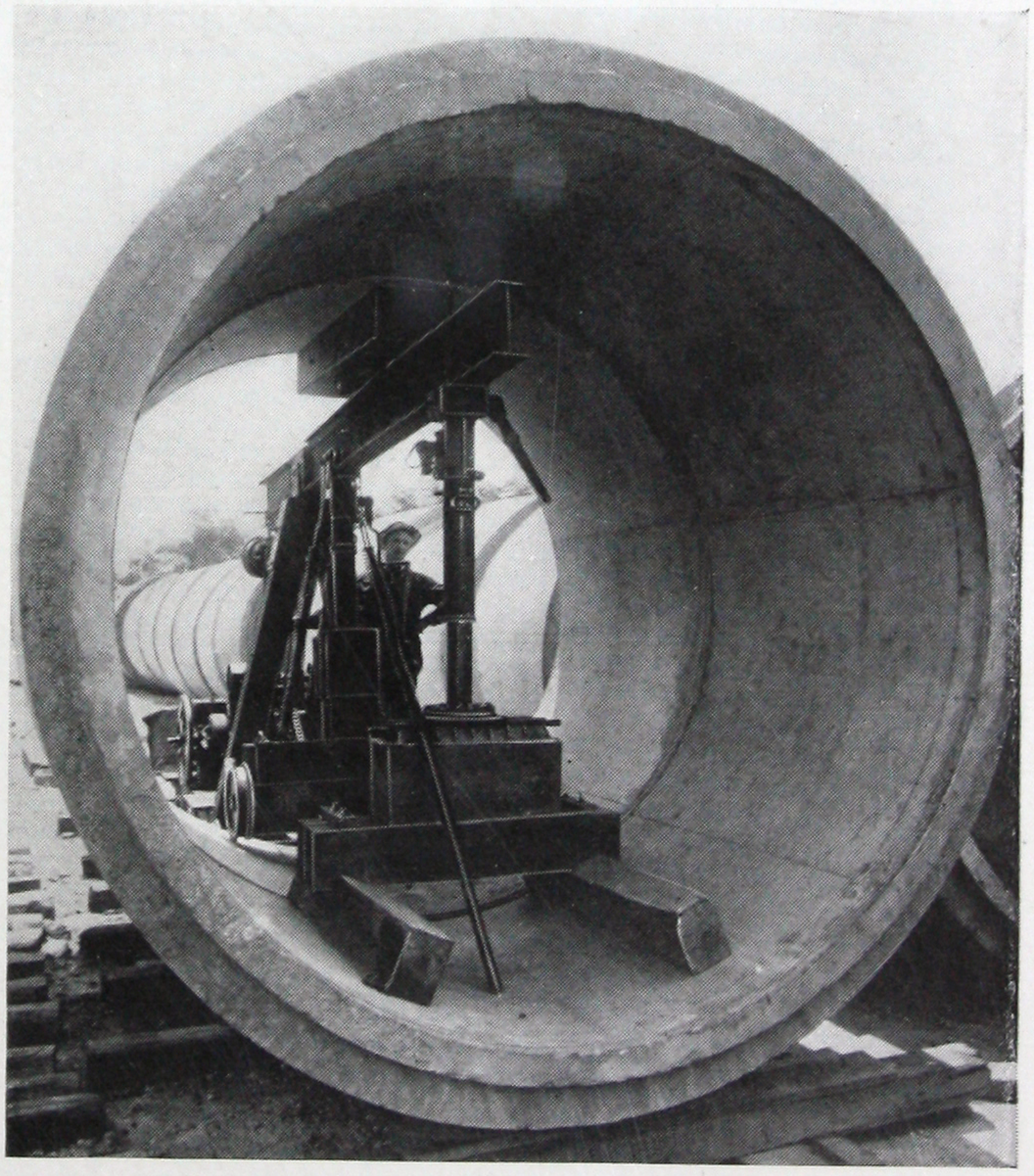
Showing Tunnel Truck Loaded and Ready to Proceed with Pipe.



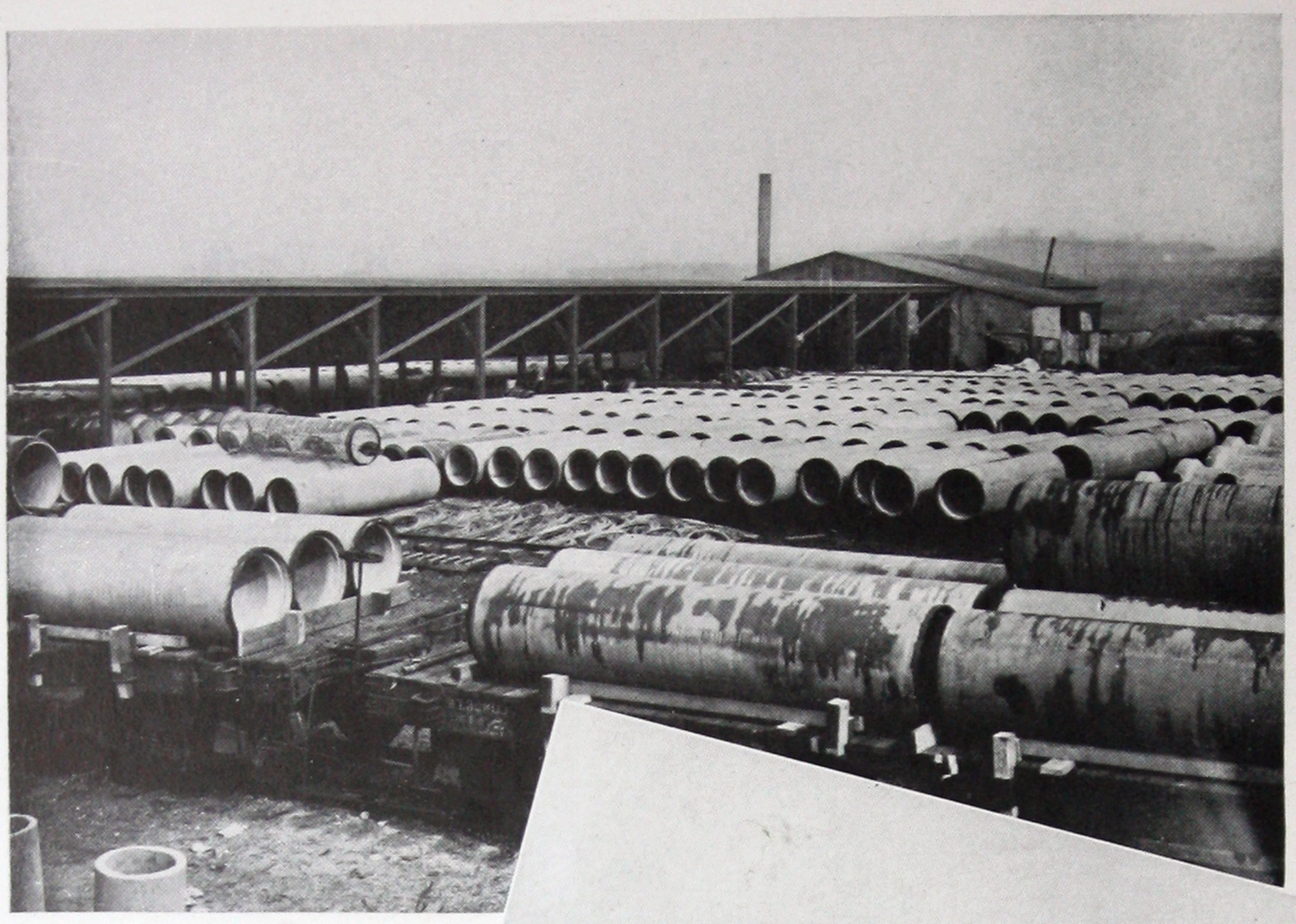
Wheels of Front Truck Before Being Raised.



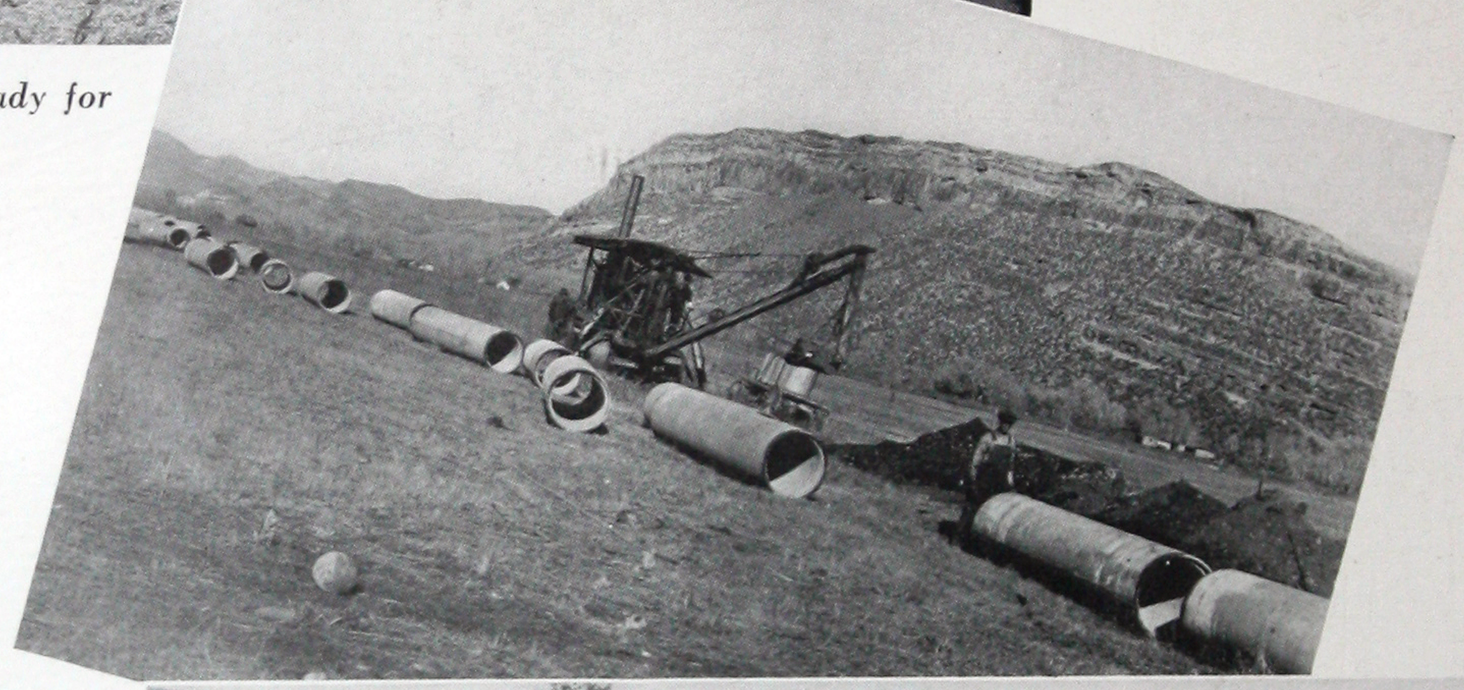
Wheels Raised and Load Transferred to Jack in Pipe Already Laid.



Showing Pipe Set and Truck Released.

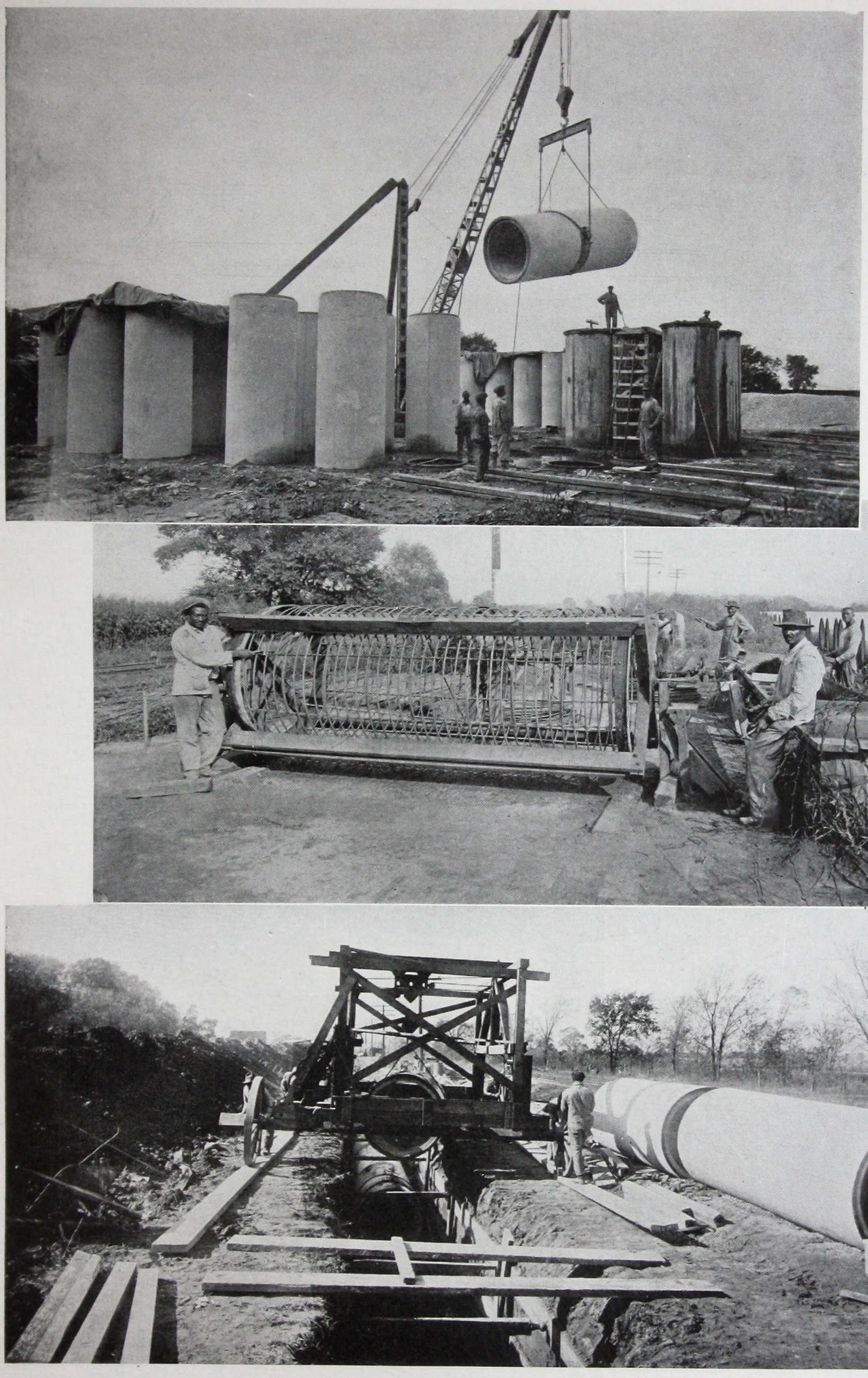


Centrifugal Pipe Ready for Shipment.





Trenching and Laying 27-inch Centrifugal Pipe.



Making and Laying 48-inch Pipe, Kansas City.



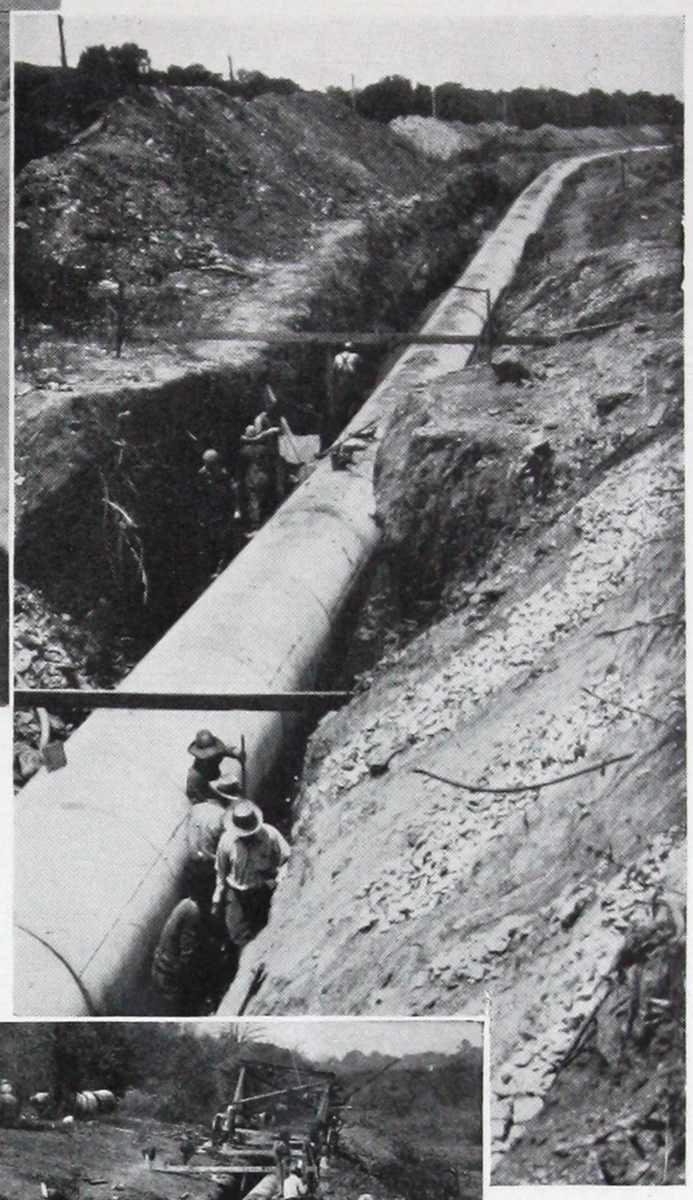
Hauling 66-inch Pipe with Dinky and Small Cars through Tunnel at Loretta Heights, Denver.

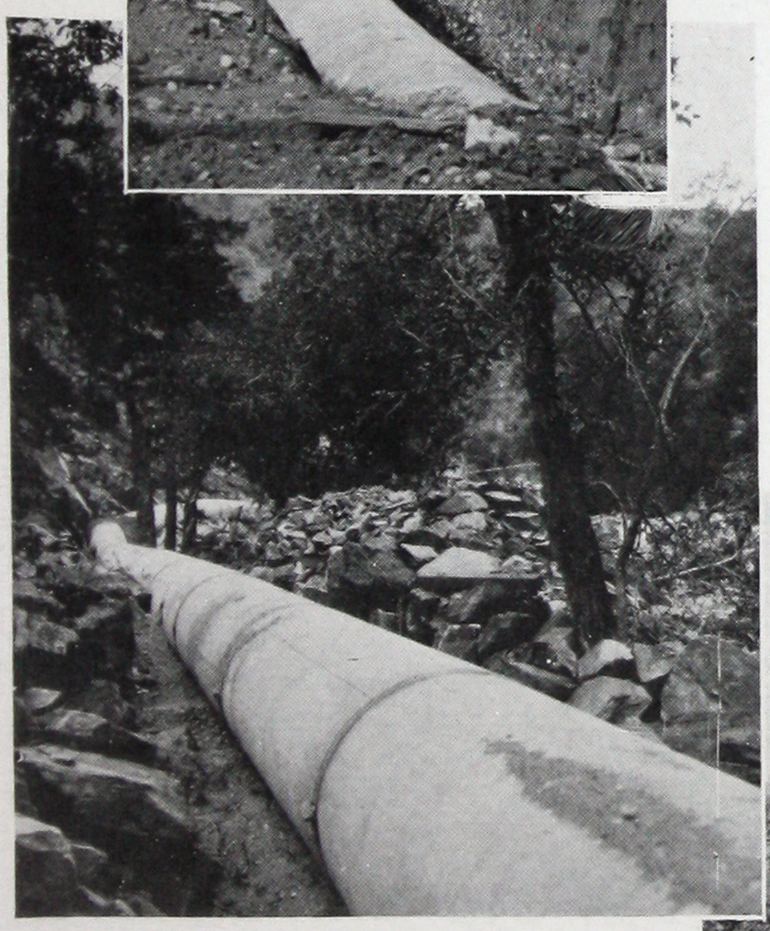


Pulling Up Joint in 20-inch Centrifugal Pressure Pipe, East Orange.





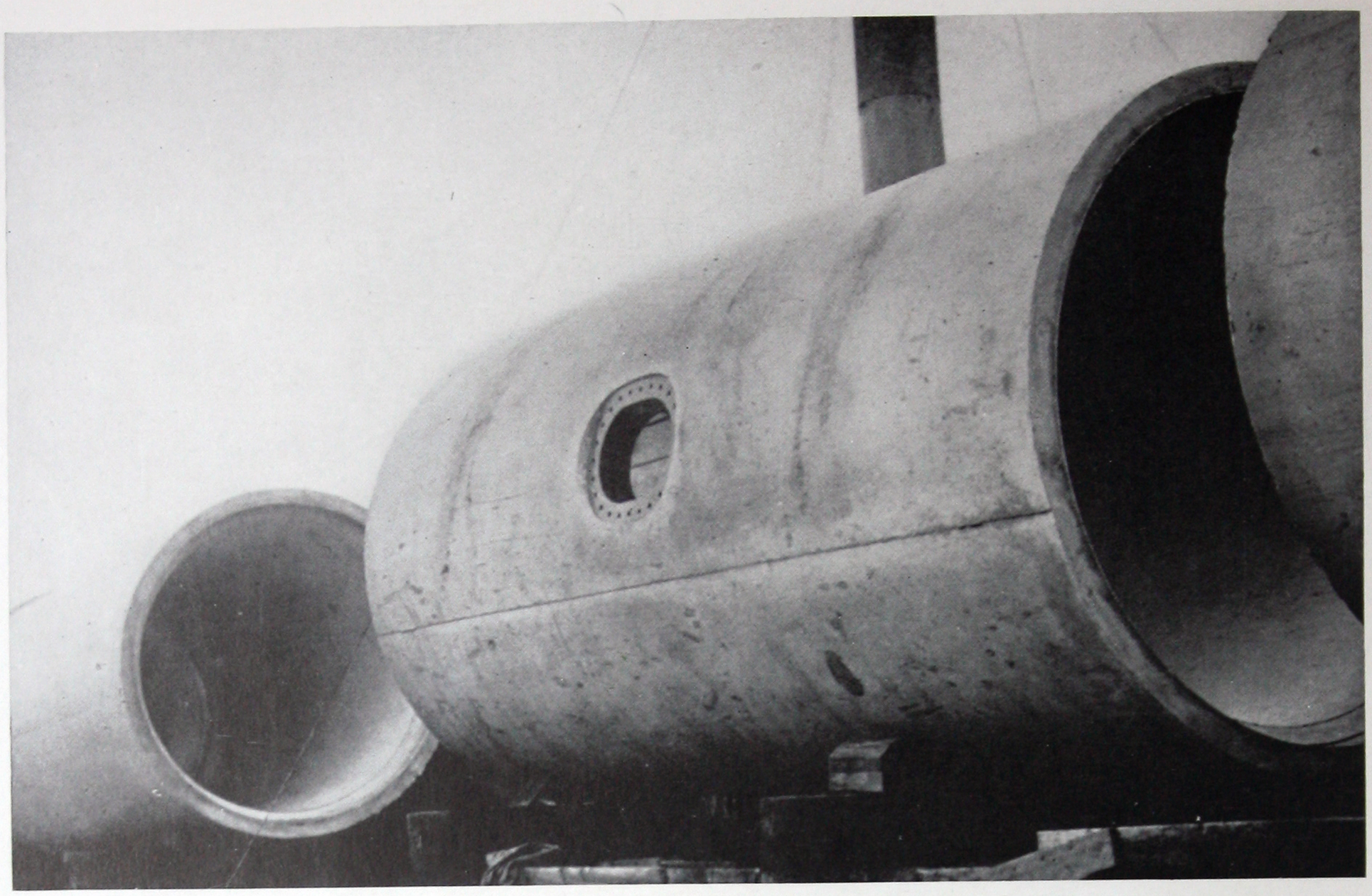








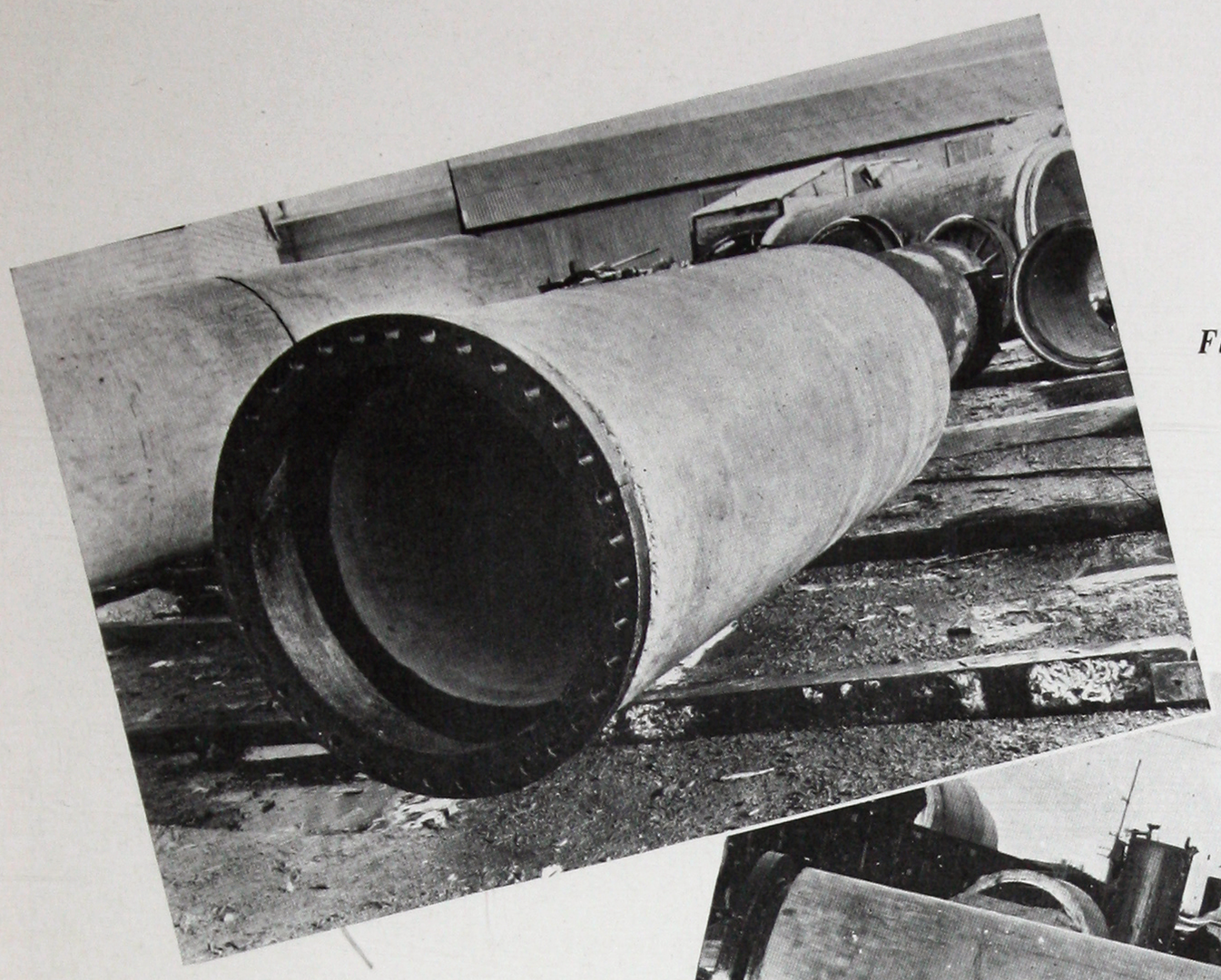
Bends in Pressure Pipe Lines Made without Specials.



Manhole Casting in Wall of Pipe.

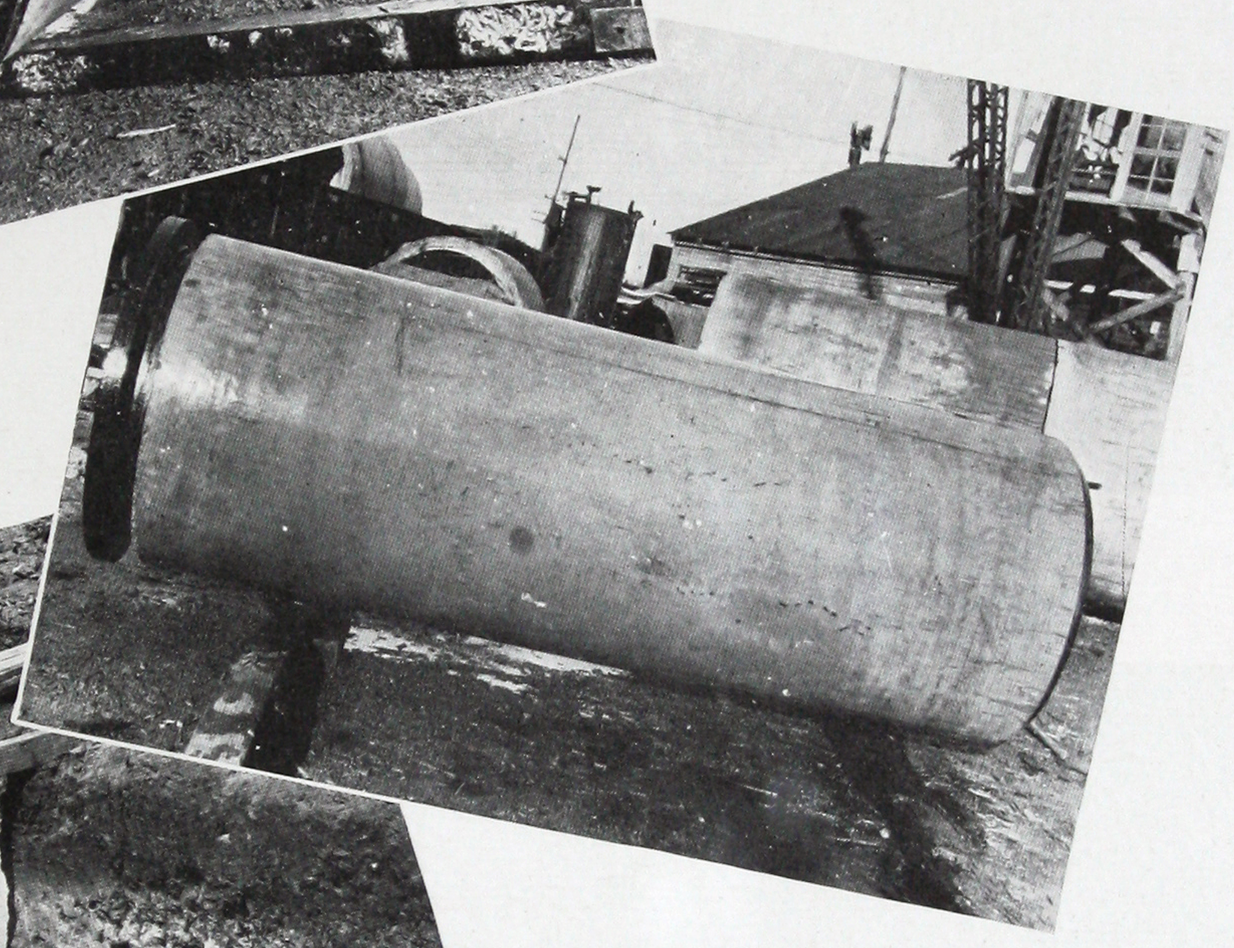


Pipe Laid in Trench Showing Open Manhole, Giving Access to Interior of Pipe.

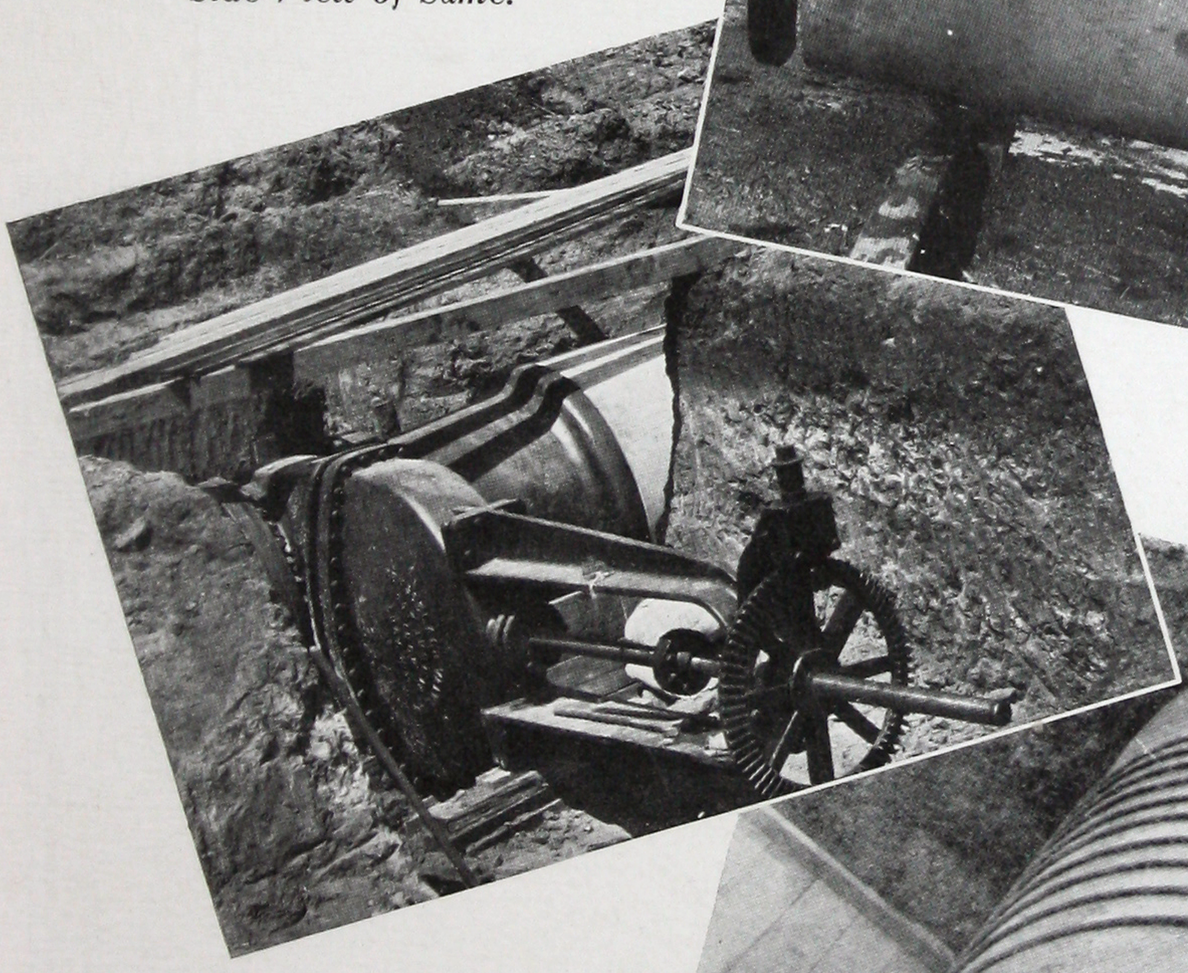


Flanged Joint Ring Cast into End of Pressure Pipe — End View.

Side View of Same.



48-inch Gate Valve Set into 54-inch Line, Denver, Showing Connection between Concrete and Cast Iron Reducer.





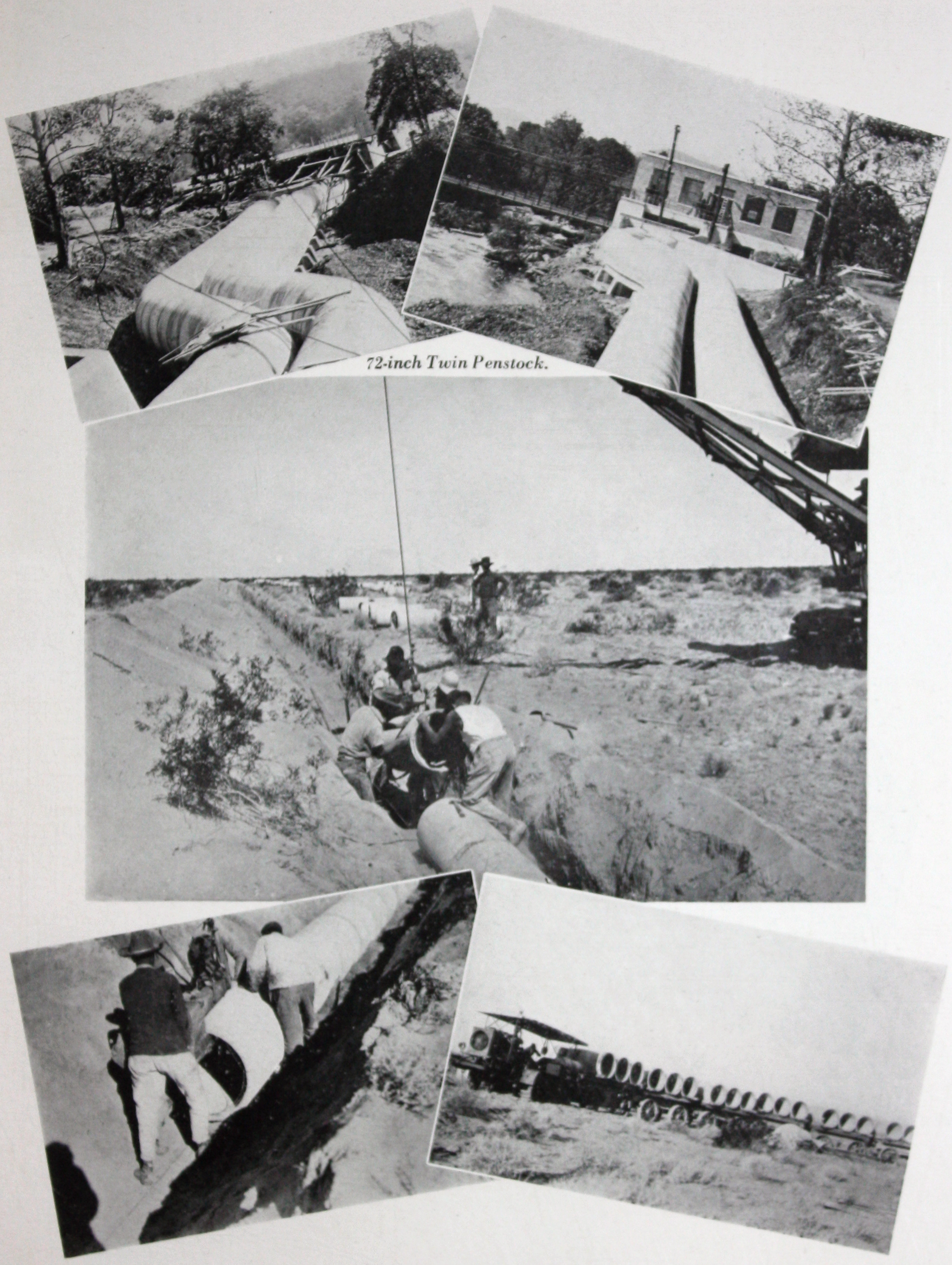
Steel Branch off of the 36-inch Pressure Line, Norfolk.



Launching 90-inch Pipe on Marine Railway out to Laying Barge, Marston Lake, Denver.



90-inch Subaqueous Pipe Suspended from Rigging on Laying Barge, Marston Lake, Denver.



72-inch Twin Penstock.

U. S. Reclamation Service, Yuma Project.



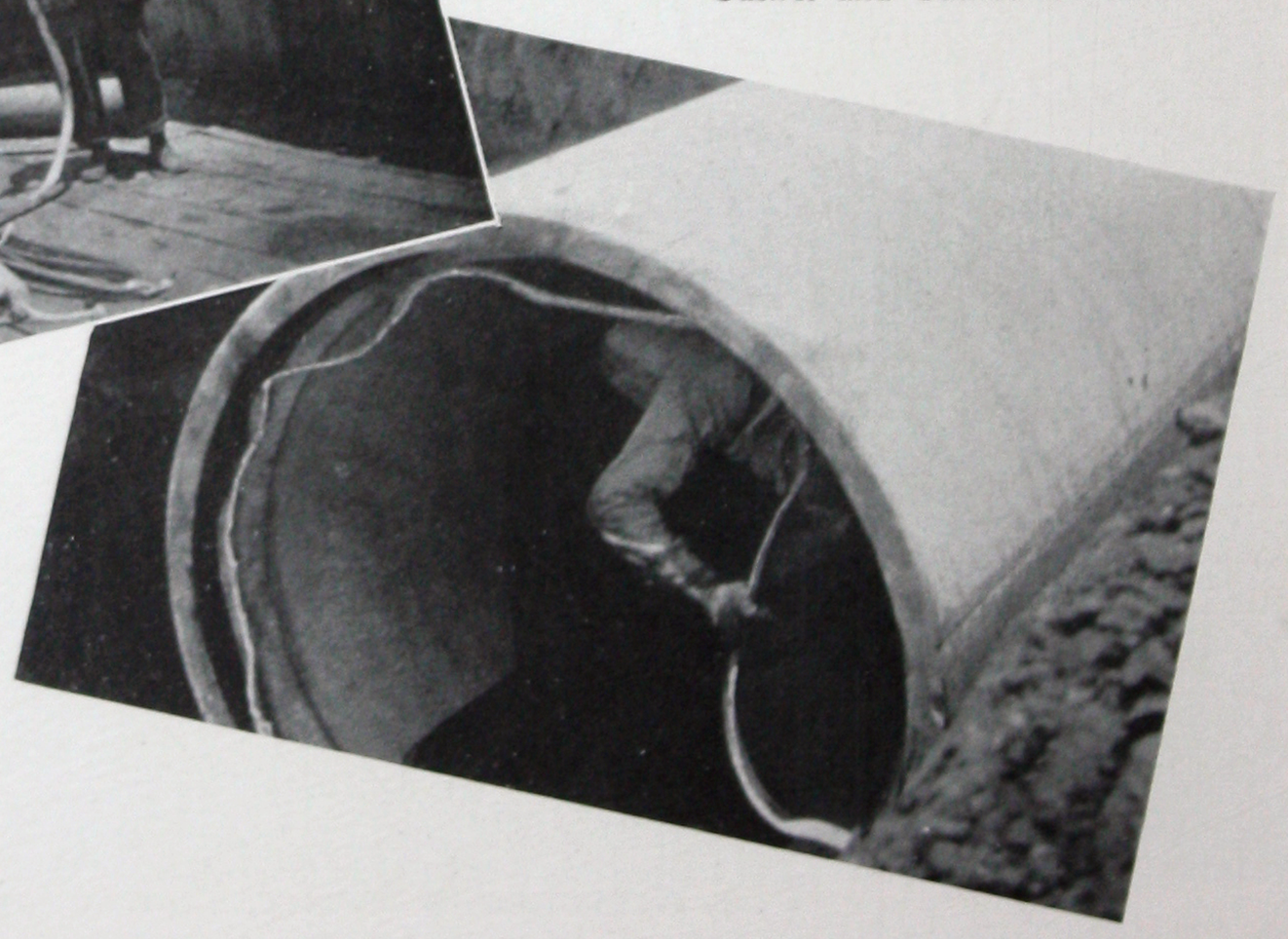
Pulling Home the Joint



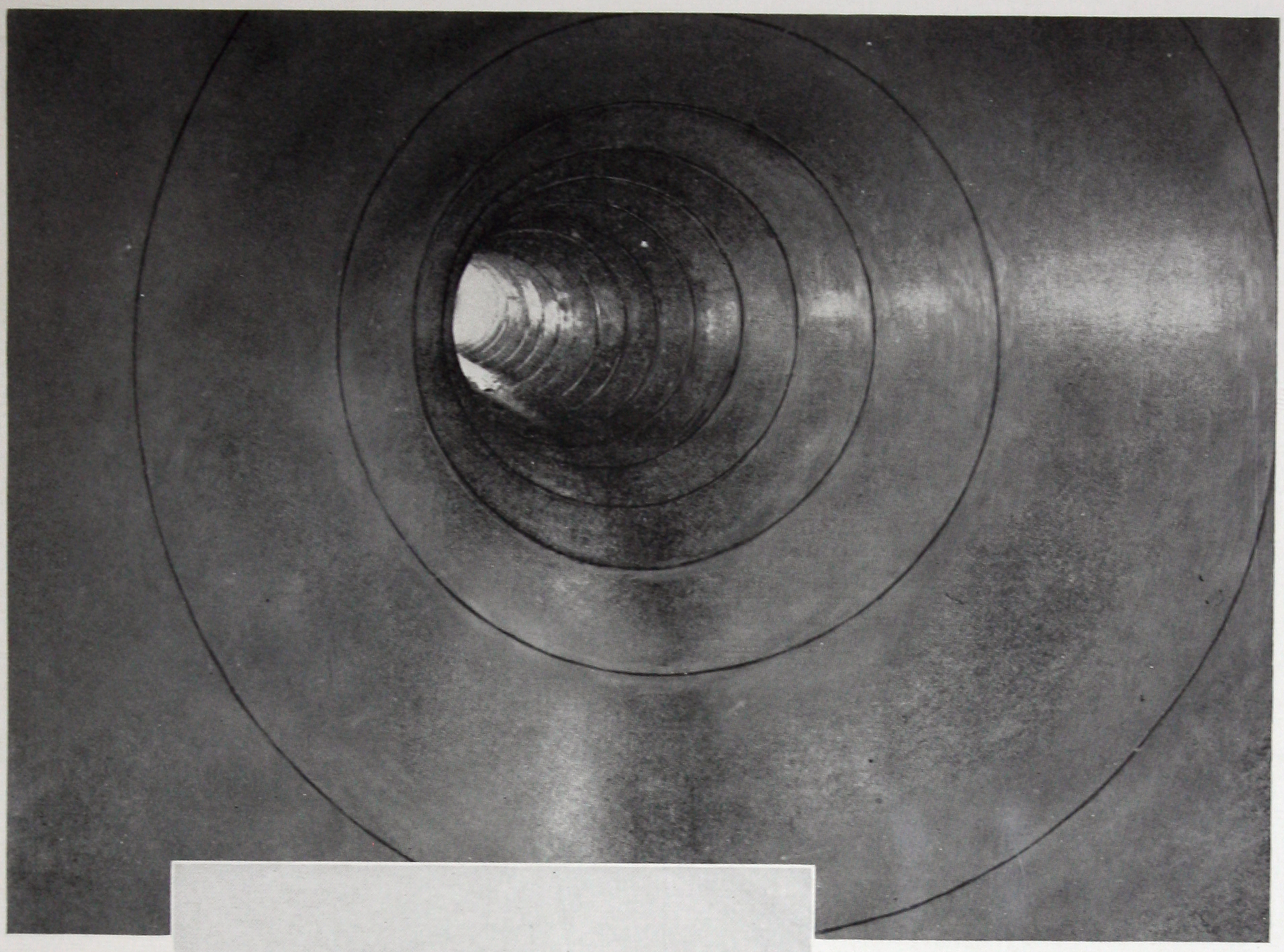
Putting Fibre-filled Lead Gasket into Position.



Gasket and Gasket Materials.



Gasket Just Unrolled Ready to Place in Bell.



A Smooth Curve in 108-inch Line, Baltimore.



Smooth!

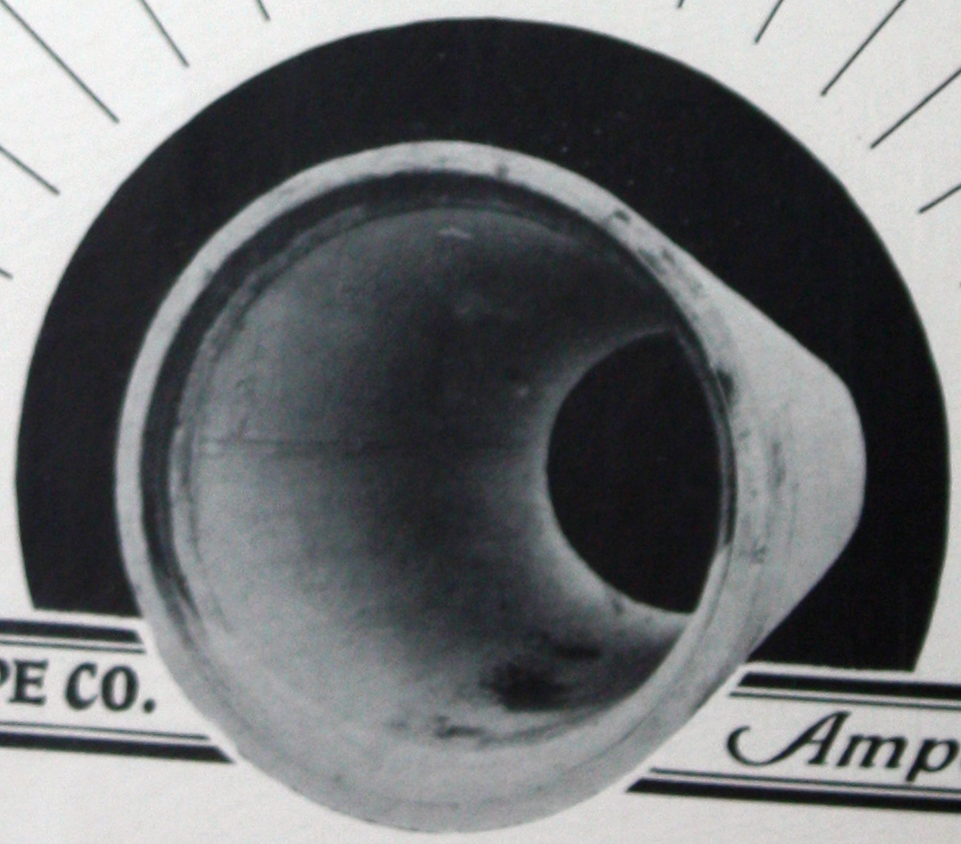
Endorsed Everywhere!

THE cities indicated have Lock Joint Reinforced Concrete Pressure Pipe lines, all giving complete satisfaction. We have faced nearly every condition as regards materials, transportation, labor, topography and climate. Such wide experience is of vital importance when a pipe line is planned which is to be permanent—to function thirty, sixty, a hundred years or more.

N
W E
S

SEATTLE-WASH
VICTORIA-B.C.
WINNIPEG-MAN
ST JOHNS-NFLD
PORTLAND-ME
NEW BEDFORD-MASS
HARTFORD-CONN
QUEENS (BORO)-N.Y.
EAST ORANGE, N.J.
BALTIMORE MD.
CUMBERLAND-MD.
WASHINGTON-D.C.
NORFOLK-VA
MILWAUKEE-WIS.
DENVER-COLO.
GREELEY-COLO.
KANSAS CITY-MO.
TULSA-OKLA
DALLAS-TEX
FORT WORTH-TEX

LOCK JOINT
Reinforced
Concrete Pipe



LOCK JOINT PIPE CO.

Ampere — N.J.

Designed A Rowden K Printed King Inc

WE WILL gladly furnish estimates to those desiring them. Inasmuch as we manufacture the pipes *in your own city* whenever the quantity is sufficiently large, it is necessary for us to have data upon which to base a reliable estimate. Therefore, whenever possible, give us:

1 — *Size or sizes of pipe required.* . . . . . .

2 — *Lineal feet of each size required.* . . . . . .

3 — *Operating head in feet.*

(a) Maximum . . . . . .

(b) Minimum . . . . . .

(c) Average . . . . . .

4 — *Send a profile of line, if possible.*

5 — *Information regarding character of country through which pipe line will run.* . . . . . .

. . . . . .

6 — *Local cost of concrete materials and state whether prices are for materials delivered or f.o.b. cars.*

(a) Sand per cubic yard. . . . . . .

(b) Gravel or crushed stone per cubic yard. . . . . . .

(c) Cement per barrel. . . . . . .

7 — *Is there a site available which it is believed will be suitable for a manufacturing yard?* . . . . . .

8 — *Has this site a railroad siding?* . . . . . .

9 — *If not, how far is it from a siding?* . . . . . .

10 — *Is water available at this site?* . . . . . .

11 — *Cost of unskilled local labor?* . . . . . .

12 — *What number of hours is prescribed locally for the working day?* . . . . . .

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